

**CONSTRUCTING HIERARCHY THROUGH ENTITLEMENT: INEQUALITY
IN LITHIC RESOURCE ACCESS AMONG THE ANCIENT MAYA OF BLUE
CREEK, BELIZE**

A Dissertation

by

JASON WALLACE BARRETT

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2004

Major Subject: Anthropology

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Approved as to style and content by:

Harry J. Shafer
(Chair of Committee)

David L. Carlson
(Head of Department)

D. Bruce Dickson
(Member)

Thomas H. Guderjan
(Member)

Lori E. Wright
(Member)

Robert L. Coulson
(Member)

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ABSTRACT

Constructing Hierarchy through Entitlement: Inequality in Lithic Resource Access
among the Ancient Maya of Blue Creek, Belize. (December 2004)

Jason Wallace Barrett, B.A., Rhode Island College;

M.A., Texas A&M University

Chair of Advisory Committee: Dr. Harry J. Shafer

This dissertation tests the theory that lithic raw materials were a strategic resource among the ancient Maya of Blue Creek, Belize that markedly influenced the development of socio-economic hierarchies at the site. Recent research has brought attention to the role of critical resource control as a mechanism contributing to the development of political economies among the ancient Maya. Such research has been primarily focused on the control of access to water and agricultural land. The examination of lithic raw materials as a critical economic resource is warranted as stone tools constituted a fundamental component of the ancient Maya economy.

My research objectives include measuring raw material variability in the Blue Creek settlement zone and its immediate environs, assessing the amount of spatial and temporal variability present in the distribution of various raw materials, determining the degree to which proximity to a given resource influenced the relative level of its use, and testing whether differential resource access relates to variability in aggregate expressions of wealth. To meet these objectives, I examined 2136 formal stone tools and 24,944 pieces of debitage from excavations across the Blue Creek settlement zone, and I developed a lithic raw material type collection using natural outcrops. Significant spatial and temporal differences were observed in the use of various raw materials.

Control of critical resources under conditions of scarcity is shown to have caused social stratification among the ancient Maya of Blue Creek. Initial disparities in use-right arrangements based on first occupancy rights produced substantial, accumulative

inequality in economic capability and subsequent achievements. During the Early Classic period, these disproportionate allowances ultimately undermined the more egalitarian structure observed during the Preclassic. The Early Classic period at Blue Creek is characterized by increasing extravagance among the elites and increasing disenfranchisement throughout the hinterlands when compared to earlier periods. This suggests that elites at the site only became fully able to convert their resource monopolies into substantial gains in power, prestige, and wealth during the Classic period.

DEDICATION

To Kim for unwavering support, steadfast belief, constant friendship, and always having more questions than I have answers.

ACKNOWLEDGEMENTS

The completion of this dissertation has been made possible through the efforts, interests, support, and guidance of a great many people. Many of these individuals may not realize the impact they have had on my research and in the final production of this work, and this I attribute to my own negligence. I would like to take this opportunity to acknowledge some of the individuals whose contributions have left an indelible mark on this volume, and whom I regard as most responsible for my achievements.

The members of my dissertation committee have been a source of continual assistance and insight. I am indebted to Dr. Harry J. Shafer for his unfailing support and encouragement. Harry's enthusiasm and knowledge regarding the intricacies of lithic analysis have been inspirational throughout the course of my research. As chair of my dissertation committee, he has entrusted me with the intellectual freedom to pursue my diverse theoretical interests while always keeping me oriented toward a realistic goal.

As a member of my committee, Dr. D. Bruce Dickson has provided endless guidance and support, and the theoretical orientation of this work owes much to his insight and influence. He has been a selfless mentor, a thoughtful critic, and a valued friend. Above all, Bruce has singularly ensured that this work has remained firmly predicated on sound scientific methods.

I owe Dr. Thomas H. Guderjan a tremendous debt of gratitude for all that he has done for me over the last several years. In addition to bringing me onto the Blue Creek project and supplying me with every resource I required with which to conduct my research, he has been a constant source of information throughout the research and writing process. In the process of completing this dissertation, I have tried to justify his generosity and the unquestioned faith that he has shown in my abilities.

Dr. Lori E. Wright has been a role model scholar. She has always provided poinient and thorough critiques and has challenged me in all endeavors to strive for the highest level of scholarship that I am capable of acheiving. I continue to be invigorated by her camaraderie as one of the only other Mayanists at Texas A&M University.

Dr. Robert L. Coulson's insights into the ecological character of landscapes and regions, as well as the impact of human actions within these systems, should be readily apparent in the text of this volume. His emphasis on the importance of environmental structure in both constraining and facilitating cultural action helped to shape the direction of my research, and has served as the cornerstone for this study.

I am fortunate to have worked with such a strong core of colleagues during the course of my research at Blue Creek. Dr. John C. Lohse, the current director at Blue Creek, has been a valuable source of intellectual discourse and an unflappable force in keeping my research focused. Dr. Laura J. Kosakowski generously provided ceramic data critical to addressing chronological aspects of lithic resource exploitation within this study. Colleen Hanratty, Robert Lichtenstein, Sarah C. Clayton, and Antoine Giacommetti, all excavation supervisors on the Blue Creek project, have each been extraordinary friends and have lent their support to my endeavors without hesitation. As longtime staff members, Colleen and Bob have been particularly helpful in providing me with the contextual data pertinent to my research.

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I would also like to express my gratitude to all the volunteers and field school students who assisted in my field excavations and laboratory analyses over that past four years. The contributions of Ira McDaniel and Gwyneth MacCubbin are particularly worthy of mention.

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Kim's insistence that the Blue Creek project sought a lithicist, and for that, among many things, I am indebted.

Finally, I would like to acknowledge the unending support and encouragement that my family has shown. I continue to be amazed by their generosity and hope that this work honors their faith in me.

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CHAPTER I

LITHIC RESEARCH AT BLUE CREEK, BELIZE: AN INTRODUCTION

Research Problems and Objectives

The ineffaceable mystique with which Western scholarship has enshrouded the ancient Maya has at long last begun to weather like the limestone walls of ancient ruins rising out through their rainforest canopy. The vision of a peaceful civilization composed of a benevolent elite class of priestly astronomers and a pious commoner class of *milpa* agriculturalists now seems little more than the quaint, antiquated musings of the field's pioneers. The socio-political organization of ancient Maya communities was as diverse across landscapes as was the regional structure and composition of their economies. This dissertation explores that diversity from the standpoint of a moderate sized site located at the geographic and cultural boundary between the Maya heartland and its periphery.

In this work I examine patterns of lithic resource procurement, production, distribution and use at the Maya site of Blue Creek in northwestern Belize (Figure 1) to elucidate dynamic cultural processes relating to the strategic nature of critical economic resources. My research has been guided by a landscape archaeology paradigm that incorporates cultural and environmental data at various orders of resolution, and also by a welfare economics paradigm that finds the basis for inequality in basal endowment disparities. These paradigms provide a framework for the spatial and temporal patterns of resource distribution and use observed in the Blue Creek settlement zone, while highlighting the role of landscape structure and cultural decision processes in creating those patterns. I use materialist models to detect inequalities in resource access and reveal the behaviors with which they associate. This approach integrates theoretical precepts from the fields of cultural ecology and modern liberal political economy to illustrate the effect of this inequality on the articulation of socio-economic hierarchies. I assume that neither cultural nor environmental influences have been the primary causal

This dissertation follows the form and style of *Latin American Antiquity*.

agents on the landscape, but rather believed that they have acted in concert. An appreciation for and incorporation of this dialectic underlies all aspects of this work.

In this study I test the theory that lithic raw materials were a strategic resource that determined the social architecture of the Blue Creek Region. The suggestion that stone tools were economically valuable commodities among the ancient Maya is not itself a novel concept. However, in this study I depart from traditional views in proposing that lithic raw material outcrops functioned as strategic resources that influenced the development of socio-economic hierarchies within Maya society. My research objectives include 1; measuring raw material variability within the Blue Creek settlement zone and its immediate environs, 2; evaluating the extent to which resources from various nodes (local, regional, and exotic) were distributed throughout the site, 3; determining the degree to which proximity to resource nodes affected activity area characteristics and relative level of raw material access, 4; assessing spatial and temporal variability in aspects of raw material utilization and distribution, and 5; evaluating the relationship between differential resource access and variability in aggregate expressions of wealth. By testing the following research hypotheses, my research offers new insight into the mechanisms and strategies employed in the development and maintenance of socio-economic stratification among the ancient Maya.

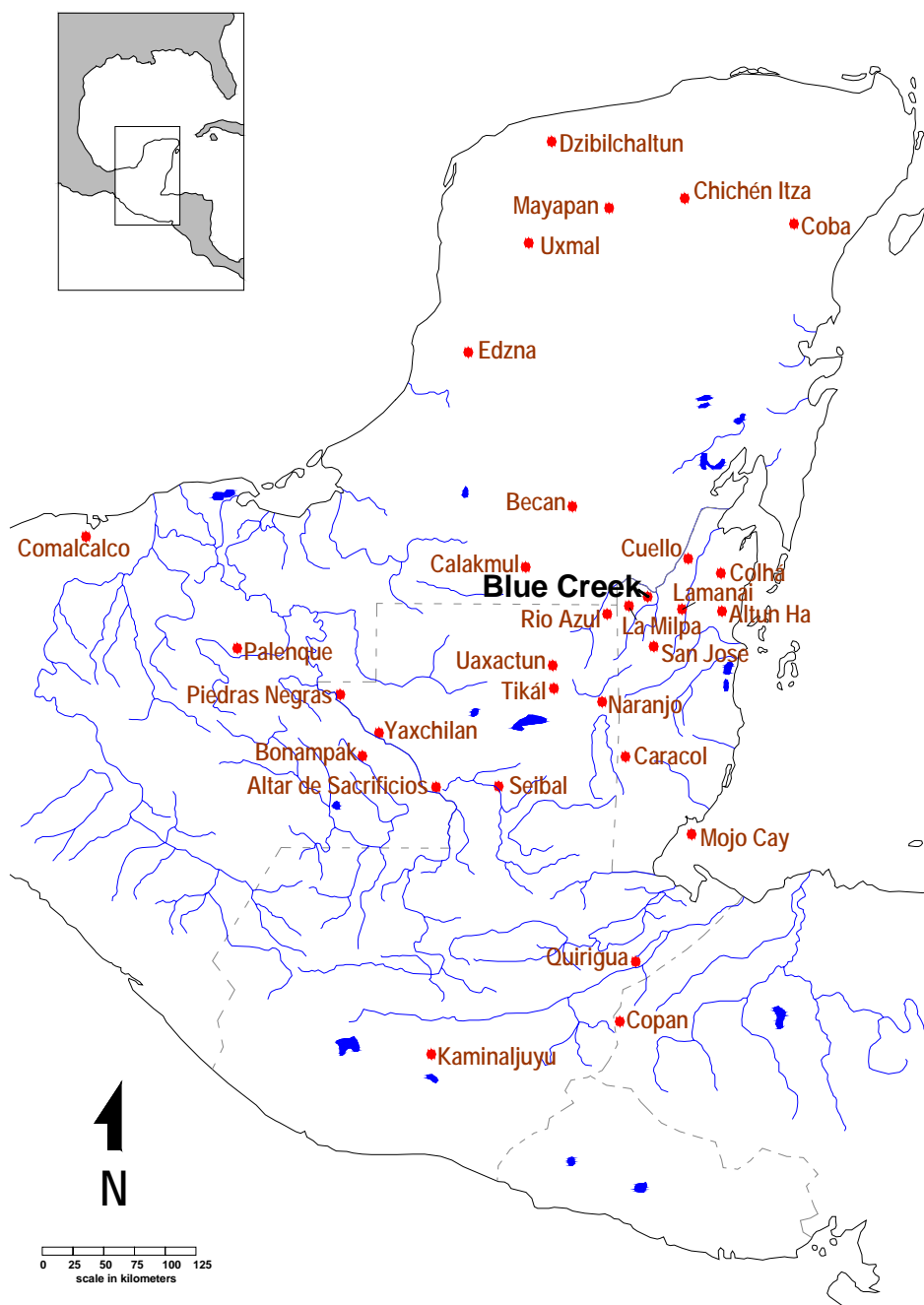


Figure 1: Location of Blue Creek, Belize and other sites mentioned in text within the Maya lowlands.

Research Hypotheses

Hypothesis One: given that local lithic resources are unevenly distributed across the Blue Creek settlement zone, the proximity to lithic resource outcrops will function as a reliable predictor of relative proportion of local resource consumption and waste.

Comparing the distribution of artifacts produced from local resources and the geographic distribution of resource nodes allows for an evaluation of both spatial variability in resource access and the influence of resource proximity on material access. However, greater proximity to lithic outcrops cannot be assumed to predict endowment bundles or a greater administrative control over the resource. Thus, I use multiple lines of evidence drawn from all available artifact classes to illustrate the complexity of human-environmental relationships within the Blue Creek settlement zone throughout the sites occupation history.

Hypothesis Two: localities exhibiting a greater relative amount of local resource conservation (proportionally fewer unutilized flakes) will exhibit relatively less local lithic resource consumption.

Several studies have found support for the view that conservation of resources is observed more frequently when scarcity is present (Bamforth 1986; McAnany 1988; Shafer 1983), reflecting the realized cost or risk of acquiring new resources. This model has been used in addressing producer-consumer relationships between sites. However, the model should also hold true for dependency relationships within economically stratified sites, such that greater conservation of local lithic resources can be expected in areas where procurement was not restricted. I test this relationship among the various settlement precincts within the Blue Creek community.

I employ two methods to measure the degree to which material from a given source area was conserved. The first measures conservation as a function of the volume of productive waste with edge modification (use-wear) relative to the total amount of productive waste. I define productive waste as debitage with enough material mass to have been used as an expedient tool form. For the purposes of this study, this includes all debitage too large to pass through a $\frac{3}{4}$ -inch mesh sieve. The second method focuses

on the number of tool forms used to material exhaustion relative to total number of formal tools recovered. Combined, these methods measure conservation as a function of the actual consumption of expedient and formal tool forms relative to potential (or optimal) consumption. Greater conservation is expected to be observed in proportion to the realized cost of material replacement.

Hypothesis Three: stone tool production is more frequently observed in localities with a greater percentage of local lithic resource consumption.

Tool manufacture will be assessed through several means. First, I study the amount of cortex present on debitage recovered in various settlement contexts. I expect production deposits to display a higher percentage of flakes with more than 25% dorsal cortex. Secondly, I use the distribution of production failures as an indication of production. Finally, I use the distribution of hammerstones as a proxy measure for determining the location of stone tool production areas. This final measure offers perhaps the most promise as the tools of manufacture are less likely to be removed from production areas than waste materials in the form of flakes or failures.

Hypothesis Four: utilitarian contexts exhibiting greater relative consumption of local lithic resources and fewer informal tools will exhibit greater wealth.

The logic of this hypothesis is grounded in modern liberal economic theory, and has been particularly influenced by the entitlement approach to welfare economics advocated by Amartya Sen (1981). Where economic needs are not satisfied through *endowments*, resources must be obtained through *exchange entitlements*. Capabilities are greater where *endowment* satisfies *need*, leaving more *convertible resources* available for non-essentials, being those items which may ultimately define economic stratification between individuals and groups. If all members of the Blue Creek community had equal access to economically vital resources, those resources would have no strategic value, and thus have little influence on *exchange entitlements* and *capability sets*. However, where direct access to such resources was not enjoyed equally by all members of the community, as is theorized for the ancient Maya community at Blue Creek, obtaining these resources other than through *endowments* would decrease

the value of *exchange entitlements* and reduce *capabilities*. Thus, the inclusion of direct lithic resource access within an individual's or corporate group's *endowment* enriched the value of their *exchange entitlement*. This may be observed in higher levels of luxury goods, greater material and energy investment into architecture and burials, and lower levels of resource conservation. The application of welfare economic theory to the study of emergent and entrenched aspects of ancient Maya political economies is further elucidated in the following chapter.

The measures of wealth I use in this study include architectural aggrandizement, distribution of jade and other exotic commodities, and burial elaboration. Considered in isolation, none of these measures is an unequivocal index of absolute wealth, although I presume most of the variability they show among various archaeological contexts provides an accurate relative measure of socio-economic stratification. If individuals or corporate groups enjoyed privileged access to lithic resources, and if these resources were indeed of strategic economic value, then greater entitlement may be associated with more substantial architectural aggrandizement, a high frequency of exotic goods, and burials exhibiting elaborate furniture and greater energetic investment.

Research Design and Procedures

In this work I address several deficiencies that exist in research on Maya lithic resource procurement, production, distribution, consumption, and discard. These deficiencies are organized into three broad themes. First, while fine-grained landscape data are beginning to appear with some frequency in lowland Maya research, their systematic consideration is still unrealized. Second, with scant exceptions, broad reconstructions of ancient Maya economy almost universally exclude data on local lithic resources, although they are one of the more visible and quantifiable measures available to the archaeologist for studying such relationships. The final deficiency in lowland Maya research addressed in this work concerns the frequent use of static models in economic reconstructions. Such models fail to address the dynamic interrelatedness of cultural and environmental agents, and do not account for processes that actively

structure and legitimize the continual renegotiation of rights and obligations throughout the social order.

My program of lithic research at Blue Creek was designed to extend over the course of three field seasons (2000-2002). I returned briefly into the field in the summer of 2003 to shore up a gap in my data. During the first and third seasons (2000 and 2002), I collected raw material samples from across the project area to construct a comparative lithic resource collection. I also analyzed all formal tools recovered since the beginning of excavations in 1991 (see methods below). All data was entered into a Microsoft Excel database, and SPSS was used for statistical analysis.

During the second season (2001), my efforts centered on the excavation of a stone tool manufacturing platform peripheral to the Blue Creek settlement zone at the site of Bedrock, approximately 12km west of the Blue Creek site core. I believe the Bedrock community shared significant economic ties with Blue Creek. I base this assessment on the large quantity of stone tools present in the Blue Creek lithic assemblage that emanated from lithic workshops located within or proximal to the Bedrock settlement zone. Finally, I directed excavations of a residential courtyard situated nearby the Bedrock resource outcrop and production area to examine the influence of resource proximity on resource consumption.

My efforts during the third field season (2002) concentrated on completing a site-wide analysis of lithic debitage. I also excavated a residential courtyard one kilometer north of the Bedrock production area to test whether proximity to resource zones affected the distribution of those resources. My excavations investigated possible midden areas, defined a chronology of occupation for the courtyard, and examined architectural construction techniques.

I chose the two courtyards based on two criteria. First, each is located in reasonable proximity to the lithic resource outcrop, so geographic distance from the resource node would not have been a limiting factor in the representation of that resource at either of the two architectural groups. Secondly, the courtyards are of like architectural complexity. Although not unequivocal, I assume that architectural

complexity provides a relative index of socio-economic status. Thus, selecting groups of like complexity may control the influence of differential economic capabilities on the representation of material resources between them. Assessing the functional redundancy and contemporaneous occupation of the courtyards was essential for drawing meaningful comparisons between the two groups.

Materials and Methods

In this study I analyze four main classes of data: lithic raw materials, formal tools, lithic reduction debris (including expedient tool forms), and their relationship to the various settlement precincts of the Blue Creek community. I also employ data from concurrent studies where relevant in addressing issues of context. For example, I use ceramic data compiled by Dr. Laura Kozakowski in conjunction with excavation matrices as a basis for defining chronological relationships.

Lithic Raw Material Analysis

The Maya Research Program's project area extends across a geologically diverse region (see Chapter III). Within this region, lithic raw material outcrops are readily identifiable among numerous bedrock exposures. The character of these outcrops is highly heterogeneous, reflecting the dynamic processes of deposition and erosion that have differentially affected this region through time. This heterogeneity allowed for the mapping of raw material source locations across the project area based on visually observable material properties (discussed in Chapter V). I collected lithic raw material samples from across the project area to provide a database documenting the diversity and spatial distribution of lithic material outcrops within the region. Exotic lithic materials noted among Blue Creek's stone tool assemblage appear to emanate from two sources. The first source area is the northern Belize chert-bearing zone (Hester and Shafer 1984, 1991). The second source area is as yet unidentified. Materials from this unidentified source are characterized by a homogenous sample of fine-grained, dark brown-to-gray chert.

Analysis of Formal Tools

My analysis of formal tools incorporated contextual and chronological data with information on raw material, material alteration, formal morphology, manufacturing stage, portion represented, failure pattern, use-wear, metric attributes, and production technology. I described all formal tools using well-established morphological categories based on physical attributes, such as production technology and design configuration (Gibson 1986; Hester 1985; Rovner, et al. 1997; Shafer 1985). Although the established type names of various artifact classes lack a standardized terminology (with terms based on behavioral, technological, and morphologic characteristics), they offer the advantage of broad recognition. I only modified terminology when necessary to prevent ambiguity between morphologic classes. Chapter V discusses the analysis of Blue Creek's formal tool assemblage in greater detail.

Analysis of Debitage and Informal Tool Forms

A great deal of information that may be obtained from the study of debitage in archaeological assemblages, and researchers have debated the utility of various classes of information, as well as their situational applicability, accuracy, and level of efficiency (Ahler 1989; Andrefsky 1998; Baumler and Downum 1987; Johnson 1989; Magne 1989; Sullivan and Rossen 1985). The variables I recorded in analysis of debitage within the Blue Creek lithic assemblage include both contextual data and physical attributes. Contextual data included archaeological context (site, structure, operation, suboperation, lot, etc.) and temporal association (Late Preclassic, Early Classic, Late Classic, etc.). Ceramic analysis performed by Laura Kosakowsky served as the basis for defining relative contextual chronologies. The physical attributes recorded for lithic debitage include size grade, raw material, platform type, presence or absence of thermal alteration, and presence and degree of edge modification. This combination of mass and attribute analysis worked efficiently for the large volume of material within in the study sample. Analytical procedures followed in analysis of the Blue Creek debitage assemblage are discussed in greater detail in Chapter V.

Landscape Archaeology

I employ settlement data both as a contextual reference and as measure of the natural environment's influence on community structure. As a contextual reference, the distribution of raw materials, specific tool types, and activity areas related to lithic reduction are of particular interest. As a measure of the environment's influence on community structure, it was necessary to determine whether or not particular settlements clustered around resource nodes and whether such settlements exhibited unequal consumption of those resources. To accomplish this, lithic resource nodes were inventoried and their distribution was compared to the distribution of residential precincts within the Blue Creek community. Artifact assemblages recovered from residential areas close to resource nodes were compared with those from residential areas at varying distances. The resulting analysis shows that resource access varied significantly with geographic distance from the local lithic resource outcrop, though marked temporal deviations were also observed (see Chapter VI).

Previous Research

Fedick (1996a: 337) has noted that landscape approaches in Maya archaeology have included works based in physical geography, the presence of road and wall networks, various methods of addressing political landscapes, and attempts to reconstruct sacred landscapes. If we are to understand landscapes, real or perceived, a standard terminology must first be adopted. In and of itself, this task continues to be an obstacle for landscape research, as the approaches taken in the study of how ancient peoples conceptualized and interacted with their environment continue to suffer from methodological inconsistencies and theoretical ambiguities. Among researchers in the Maya area, methods oscillate between materialist definitions predicated in earth sciences, such as geography and ecology (Dunning 1992; Fedick 1996; Rice 1993), and idealist definitions predicated in less material disciplines such as philosophy and psychology (Freidel et al. 1993; Knapp and Ashmore 1999; Schele 2000). Within the

framework of this research, I adhere to a materialist definition of landscape that puts a priority on geological structure and the arrangement of biotic and abiotic elements.

Cross-cultural research from all regions of the world has shown that differential access to strategic resources forms the basis of social stratification among complex chiefdoms and incipient states (Earl 1991a; Fried 1967; Johnson and Earl 1987; Kristiansen 1991; Sahlins 1972; Service 1975). Critical economic resources occur with varying degrees of scarcity, and access to them among stratified societies is not uniform, but scalar. The most critical resources for any society are access to potable water and food. These resources constitute the core elements of any economy, and may lead to significant stratification within groups where inequality of access is maintained. The Classic period Maya were heavily reliant on stone as a raw material used in manufacturing tools that enabled the normal functioning of everyday life. Not all stone is suitable for the production of tools, and resources nodes yielding suitable material are finitely distributed throughout landscapes and regions. Therefore, controlling access to this vital and limited commodity, particularly in areas of greater scarcity, would have afforded those with the privilege of unrestricted access an economic advantage over those without access.

The commercial importance of lithic resource nodes and stone tools is documented ethnohistorically (Tozzer 1941), and was addressed in early lowland Maya research (Blom 1932). Several recent studies have made significant contributions to understanding the commercial significance of stone tools (Aoyama 1999; Clark 1988; Dockall and Shafer 1993; Fowler 1991; Hester and Shafer 1984, 1991, 1994; Lewis 1995; McAnany 1988, 1989b; McKillop 1996; McSwain 1991; Santone 1997; Shafer and Hester 1983; VanDenBosch 1999). While such studies illustrate the commercial importance of stone tools from the perspective of both producers and consumers, as well as that of mid-network trade ports (McKillop 1996; Mock 1994b, 1997), few have addressed the potential role of differential access to local lithic resources in defining social relationships within communities (but see King 2000; King and Potter 1994). In my work, I seek to fill this void by focusing on the relationship between local lithic

resource consumption and realized capabilities. This approach ultimately provides a better understanding of the financial institutions which supported the development of political economies and the disproportionate distribution of power, prestige, and wealth between individuals and groups.

Chapter Overviews

The theoretical underpinnings of this work are more fully elucidated in the next chapter. Chapter II begins by discussing the use of economic models in addressing social inequality. Following this, I review the salient features of economic systems and the characteristics of political economies. I then assess the nature of various resources with reference to their role as economic staples, critical resources, or resources with strategic economic value. Next, I examine the applicability of the entitlements approach in welfare economic theory to the study of ancient Maya socio-economic structure. I address the development of incipient social stratification with respect to the inequitable distribution of resource use-rights, which provides a means to enforce alienation; ideological sanctioning of resource appropriation and wealth accumulation; and available methods for converting resource claims into wealth. Following this, I explain the landscape archaeological paradigm that underlies and structures this work. The landscape archaeological paradigm focuses on the continuous exchange of influences taking place between human and environmental forces at various orders of resolution. The chapter concludes with a discussion of the applicability of different economic models to characterize the finance systems that supported the development and growth of political economies among the ancient Maya.

Chapter III introduces the site of Blue Creek, Belize. I first discuss the geological history of the region, and then describe the landscape structure, emphasizing geological and ecological attributes, as well as the distribution of economically important resources. Following this, I present the chronology of investigations at the site, including a description of the various settlement precincts within the community. I also discuss relevant areas of investigation beyond the Blue Creek community, such as

the courtyards and lithic workshop located in the *bajo* region to the west. I survey material analyses already undertaken or currently being completed by various other researchers at the site, and discuss what is currently understood regarding the historic development of the Blue Creek community. This includes a review of site attributes during each of the major lowland Maya time periods. I then review the geopolitical features of prehispanic northwestern Belize (to the extent that such features are currently understood). This discussion places Blue Creek in the wider developmental context of northwestern Belize sites and includes a rank size comparison of sites in the “Three Rivers Region” (Scarborough, et al. 2003). Finally, I provide a summary discussion of the significance of the Blue Creek polity with respect to the broad endeavors of lowland Maya archaeology.

Chapter IV presents an overview of lithic research in the Maya lowlands. I begin this overview with an examination of research conducted with respect to non-obsidian flaked stone during several broad developmental periods, from early research of the Peabody Museum at Harvard University, the Carnegie Institute of Washington, to research centered at and following from investigations carried out at the site of Colha, Belize. I then contrast technological with contextual approaches to lithic analysis and evaluate the contributions of each. Finally, I offer a critique of Maya lithic research that emphasizes the disparity in analytical attention that exists between obsidian and non-obsidian flaked-stone artifacts.

Chapter V presents the analytical methodology used in studying the Blue Creek lithic assemblage. I first discuss the methods and equipment employed in the analysis of artifacts and then explain the procedures used for identifying and characterizing lithic raw materials. Next, I describe the methods used in the analysis of formal tools, including a discussion of morphological classification, the assessment of manufacturing trajectory, the identification of use-derived edge modification, motivations for discard, and the various causes of material alteration. Finally, I present methods used in the analysis of debitage, including a discussion of size-grade analysis, raw material

sourcing, cortex classification, the determinants of platform type, and the identification of use-derived edge modification.

Chapter VI presents the formal analysis of the Blue Creek lithic assemblage and tests each of the four research hypotheses presented above. The chapter begins with a discussion of spatial and temporal patterns observed in the distribution of lithic resources within the various settlement precincts of the Blue Creek community. I discuss evidence of stone tool production at Blue Creek, and then assess relative resource conservation. I evaluate tool production and material conservation from a spatial perspective that focuses on contrasts between the various settlement zones comprising the community, as well as from a temporal perspective that illustrates change in observed patterns through time. Finally, I readdress and evaluate the theory that lithic resources were of strategic economic value, contributing to an inequitable distribution of power, prestige, and wealth throughout the community.

In the final chapter, I review the major themes and findings of this work including the organization of resource access, the institutionalization of inequality, the nature and degree of hinterland autonomy, and the complexity of economic decision processes. I also discuss the role of external economic relationships and the motives for inter-polity commerce. Finally, I discuss the contributions this work offers with regard to archaeology at Blue Creek and to Maya archaeology in general, placing a particular emphasis on the relevance of lithic research in studying dynamic economic process among the ancient Maya.

CHAPTER II

THEORIES ON MAYA POLITICAL ECONOMY

Introduction

This work addresses fundamental attributes of both the economic and political character of ancient Maya society. This chapter begins with an overview of current methodological approaches and explanatory models related to Maya political economy. The overview explores research on the institutional basis for the development and maintenance of social inequality and establishes the theoretical underpinnings of this work. Contextual analysis of such institutions is facilitated through a landscape archaeological approach, and the socio-economic effects of realized inequality in resource use-rights are made more intelligible when examined within the framework of welfare economics. Tributary models that rely on normative rights and obligations for the mobilization of resources are next compared with more overtly economic models in which contrastive entitlements and capabilities between individuals and groups account for the distributional pattern of scarce and valued resources. Finally, I discuss the benefits economic models offer for bringing the dynamic aspects of Maya political economy into sharper focus.

Economic Models and Social Inequality

Paul Diesing has stated that “the strength of a perspective consists of its ability to bring certain aspects of society into clear focus thereby making their empirical study possible; the weakness of a perspective consists of the way it distorts or hides other aspects of society” (1982:12). Many philosophers and theoreticians from disparate fields of knowledge have lent their insights, if unwittingly, to archaeological models. Drawing on the information and vocabulary they provide, archaeologists have developed many innovative approaches to studying the material record of past civilizations. The choice of paradigm among researchers often reflects their perception of one or another model’s ability to accurately represent relationships in the past, possibly evaluated by

how well they believe the model illuminates comparable relationships as they exist in the present. A useful supplement to Diesing's statement may then be that the "certain aspects of society" we value and desire bringing into focus may vary quite markedly, and the emphasis placed on these aspects is largely a reflection of our own world view. Beyond this however, there can be little question that the efficacy of some models is superior to that of others in addressing specific social relationships.

The goal of this work is to bring into clearer focus the foundations and maintenance institutions of social inequalities among the ancient Maya. Political economy models offer a systemic perspective through which the direction and intensity of resource flows can be observed and understood. Welfare economics are used, specifically from an entitlements approach, to examine the effects an inequitable allocation of use-rights has on the development and perpetuation of socio-economic inequality.

Economy and Political Economy

Economic systems are manifest in all societies, though their constitutive elements and scale of complexity vary considerably. Economies include the procurement, processing, distribution, and consumption of goods and services within a society. Economic processes may be embedded within political, religious, and kinship systems, and reflect the capabilities and limitations of techno-environmental influences (Schusky and Culbert 1987; Harris 1979). The component parts of an economy affect and are affected by these other features of the social system, such that the developments in one part of the system often cause concomitant developments throughout the system as a whole.

In studying past economies it is essential to realize that they are not only comprised of their material parts, which are most easily observed by archaeologists, but are also made up of culturally negotiated and legitimized patterns of behavior, as well as the beliefs and attitudes associated with these behaviors. These beliefs and behaviors structure the direction and intensity of material flows, and are as critical in

understanding economic systems as the techno-environmental basis of subsistence that characterizes the system. The challenge of archaeology is to understand the beliefs, behaviors, and organizational structures of past cultures through their material remnants. Theories of political economy have arisen to explain the inequitable distribution of human and material resources in society by examining the endogenous institutions, patterns of behavior, and ideologies on which it is founded and justified.

Theories of political economy principally relate to the development, characteristics and distribution of economic surplus (Pressman and Neill 1999: 854). In its archaeological usage, political economy typically refers to “the control or management of significant components of the economy by elites, who thus facilitated the acquisition, maintenance, and augmentation of their high positions, prestige, wealth, power, and authority” (Webster 2000:187; cf. Masson and Freidel 2002). A study of political economy is then a study of the institutional basis for social inequality, and the model assumes that the differences realized between individuals and groups in economic capability and entitlement to the use of coercive power are based on the manipulation of productive resources. Social inequality “appears inextricably linked to processes associated with the development, expansion, and institutionalization of resource-accumulation mechanisms” (Hirth 1996:221-222). There are two fundamental features of the political economy model. The first component of the model states that resources may be converted into material and political claims, and that some resources, by their nature, may be more productive in this capacity than others. The second component of the model states that within a society, avenues exist for some individuals and groups to alienate others from direct and unrestricted access to or exploitation of these resources. A discussion of these components follows as each merits more thorough consideration.

The Nature of Resources

Resources may be defined as any material or skill that fulfills a real or perceived need. Focusing on materials, the nature of resources may be described as being staple, critical, or strategic, though these categories are not mutually exclusive and individual

resources may fit any or all categories. A staple resource describes a commodity having widespread and constant use or appeal. Staple resources may or may not be critical. Regardless, they may have strategic value to the extent that their demand can be maintained and their supply can be regulated.

Staples resources are not considered critical when alternatives exist, even though such alternatives may not be preferred. An architectural example may illustrate this point. For the Maya, there existed no contradiction or conflict of cultural identity whether one lived in a wattle-and-daub structure or one constructed of limestone masonry. The condition of living in one or the other may have held implicit meaning with regard to the status and capabilities of its residents, but neither represented a transgression against the Maya lifeway. Therefore, while limestone suitable for use in monumental architectural construction was unquestionably a staple resource throughout much of the Maya lowlands, it should not be considered a critical resource, regardless of its desirability. This does not imply that only critical resources are significant determinants of behavior. The availability of well-consolidated limestone has in fact been shown to have had a substantial influence on lowland settlement patterns (Fedick 1996a: 345).

Critical resources then, in a narrow sense, can be defined as those resources that are necessary for the maintenance of life or the preservation of a specific lifeway. They lack alternatives, are always staple resources, but are not necessarily strategic in nature. Resources are regarded as strategic when their access can be controlled by a limited number of individuals, producing economic rewards for those managing use-rights. Strategic resources may or may not be staple or critical in nature. Both jadeite and cacao functioned as strategic resources due to their value and limited accessibility, yet neither was necessarily critical to the preservation of the Maya lifeway.

The most critical resources for any society are access to potable water and dietary resources. These resources constitute the core elements of an economy, and may lead to significant stratification within groups where inequality of access is maintained. However, while potable water was a critical resource, it would not have been strategic in

regions of abundant rainfall or in areas proximal to freshwater lakes, lagoons, or rivers. For a resource, critical or otherwise, to be of strategic value, it must be alienable. Several authors have suggested that Maya elites maintained their status through controlling reservoirs and agricultural land (Dunning et al. 1999; Ford 1996; Scarborough 1993, 1998). Although these resources were certainly of paramount importance, and were likely the most influential for establishing socio-economic hierarchies, there were other resources critical to maintaining the Maya lifeway. The critical nature and strategic value of potable water, agricultural land, and utilitarian stone are examined in more detail below, although these were not the only resources essential to maintaining the Maya way of life. Briefly, wood was needed for cooking fires and architectural construction, clay was needed for pottery manufacture, and cotton was needed for textiles.

Water

Potable water is fundamental to the maintenance of all human life regardless of economic organization, and several researchers have noted the variability in its distribution and availability across the Maya lowlands, suggesting the strategic potential in monopolizing its access (Ford 1996; Lucero 1999; Matheny 1978; McAnany 1990; Scarborough 1993, 1998). Arguments for elite monopoly over use-rights to potable water sources in areas of scarcity typically rely on the proximity of procurement nodes, usually in the form of catch basins, to elite residences. Scarborough, for example, proposes that elites maintained administrative control over large reservoirs within the ceremonial precinct at La Milpa (Dunning, et al. 1999). Further, Brady and Ashmore (1999) suggest that the physical containment of such resources in physical proximity to elite residences would have provided a stage for state ceremony, which in turn mobilizes the vertical transfer of commodities and services from commoners to elites. State ritual reinforces and is reinforced by the provisioning ability of elites, legitimizing the tributary economy. This scenario also may be viewed in more overtly economy terms, with elites converting resource monopolies into claims on peasant surplus. Ritual may

have served to legitimize this relationship, but commoners were not necessarily mystified, unaware of the essentially exploitative nature of their situation. Carneiro offers a poignant caution, stating that the actions of individuals need not be motivated by ideology, but may simply reflect “a direct perception of reality or necessity, unrefracted through the lens of symbolism” (Carneiro 1992: 179).

The essential flaw in “control by proximity” arguments is that their utility is limited in both their ability to address the full coercive potential of rulers, and their ability to explain administrative relationships governing resource use-rights in general. By focusing on proximity as the basis for entitlement inequalities, these arguments fail to provide a mechanism for elites to administer resource use-rights outside the confines of their residential precincts. This becomes relevant when considering the strategic potential of a variety of resources, particularly agricultural land. The next chapter will discuss the distribution of channelized agricultural fields at Blue Creek in greater detail. However, it is germane to mention at this point that this network of fields extends from the base of the Rio Bravo escarpment and is bordered by an extensive, non-elite settlement community along its eastern periphery. The fact that this community borders a highly productive agricultural zone did not furnish its members with the material trappings of nobility. To the contrary, structures in the savannah settlement zone below the escarpment exhibit little of the labor and material investment observed in elite architectural and burial elaboration, and they provide much less evidence for the consumption of jade and other exotic commodities. Although Blue Creek’s elite reside at some distance from this resource zone, on the escarpment’s upper plateau, their overt expressions of wealth and ability suggest that they differentially benefited from the productive potential of resources within their sphere of influence. If proximity to a resource legitimized its monopoly by some to the alienation of others, the hinterland non-elites of Blue Creek certainly made little use of the productive potential of their endowments. For use-rights to fertile agricultural land to have been strategically monopolized by Maya elites, a mechanism for legitimizing this relationship other than proximity to the resource must have been in place.

Agricultural Land

Fertile soil amenable to horticultural or agricultural pursuits was critical to the ancient Maya lifeway, if only so given the structure of their subsistence economy. Human populations existed in Central America prior to the cultivation of plant resources. But while the archaeological remains of hunters and gatherers have been recovered throughout Mesoamerica, these groups appear distinctly non-Maya, lacking all the accoutrements of culture researchers use to distinguish the Maya as a distinct ethnic group (Coe 1999). There is ample evidence that the Maya defined themselves and their relationship to the world around them through plant cultivation. Maize was particularly important in this regard. Abandoning plant cultivation and returning to a mobile foraging subsistence strategy would have been highly undesirable to the Maya as they linked their very identity and cosmological origins to the cultivation of maize. Agriculture was of fundamental importance to the Maya lifeway, thus fertile land may be viewed as a critical resource.

The importance the ancient Maya placed on arable land is not disputed, although there is little certainty regarding the normative rules that governed access entitlements, the ability for individuals and groups to generate surpluses, and decisions regarding crop structure. Emic distinctions of common and private property are at best opaque, as are the motivational forces behind elaborate landscape modifications that acted to increase an area's productive potential. Most researchers adopt one of two views toward fertile soils or the products they yielded. In the first view these resources are managed by corporate kin groups, and individuals were endowed with inalienable use-rights regardless of social status based on the reciprocal obligations of kinship (cf. Fox, et al. 1996; Hageman and Lohse 2003). The second states that elites asserted proprietary control over all productive resources, thus acquiring claims to both labor and goods in return for granting use-rights (McAnany 1993:80-83; Sanders 1992). The accuracy of either model has little impact on the *critical* nature of the resource, but it has significant implications for whether or not the resource was of *strategic* value.

Utilitarian Lithics

From their formative beginnings through their conquest by Spaniards, the Maya were heavily reliant on stone as a raw material used in manufacturing tools that enabled the normal functioning of everyday life. Utilitarian lithic raw material, defined as that suitable for the production of tool forms, was at the core of Maya subsistence technology, and therefore a critical resource. Not all stone is suitable for the production of chipped stone tools, and resource nodes yielding suitable material are in finite distribution throughout landscapes and regions. Controlling access to this vital and limited commodity, particularly in areas of greater scarcity, would have afforded those with the privilege of unrestricted access and use-rights an economic advantage over those without.

Like fertile soils amenable to agricultural production, the fundamental importance of utilitarian lithic resources is a product of the Maya mode of subsistence. Well-consolidated limestone was an important element in architectural construction in most areas of the Maya lowlands. However, alternative construction materials were employed in its absence, from the simple wattle-and-daub structures ubiquitous in hinterland settlements zones, to shell and coral structures found at some island communities (Graham and Pendergast 1989), to the monumental fired brick structures observed at Comalcalco (Andrews and Hardesty 1989). There were fewer available alternatives for stone that could be crafted into tool forms. Tools of shell, bone, and antler have been recovered in excavations throughout the lowlands, and others were likely crafted from wood. Such tools, however, could not have been used for the full range of tasks performed in Maya society. Activities such as quarrying stone, cutting and shaping timber for architecture or manufacturing canoes, and various other resource processing tasks required the use of stone tools. Two types of stone commonly found in lowland archaeological contexts are chert and obsidian. Obsidian was imported from highland source areas to variable degrees throughout the lowlands. However, obsidian is not nearly as prevalent as chert at most sites, nor was it used in the same capacity as

chert. Obsidian has a lower tensile strength than chert, rendering it inefficient for a variety of tasks.

Until the Late Postclassic period, the Maya lacked a practical knowledge of metallurgy. As such, utilitarian stone and the products crafted from it were an important and irreplaceable element of their economy.

Commodity Value

Material resources have natural or social value (c.f. Clark 1999). Resources with natural value are those that address survival needs; they are necessary for subsistence, protection, and reproduction. While they may have substitutes, they cannot go unfulfilled. They constitute basal necessities and include staple nutrients, potable water, and utilitarian raw materials. As they are critical to the survival of individuals and societies, their access constitutes a dynamic and decisive variable in the organizational character of societies. Access to such resources may remain unrestricted as natural conditions or social institutions may deter, preclude, or prohibit individuals from gaining differential access to them. Open access and common property arrangements ideally fit this model, though access restrictions may apply to individuals who are not recognized as members of the social group. Under open access or common property arrangements few substantial differences are likely to exist in the distribution of resources within the group. However, in societies composed of diverse groups, whether categorized by ethnicity, class, caste, social race, or kinship, the corporate control of critical resources may be strategically managed by one particular group to create and maintain an advantageous distribution of power or influence. Legitimizing differential access to critical economic resources is a definitive step in the institution of social stratification.

Finally, resources with social value may similarly play a role in the development of economic inequality, but are more likely to have a greater role in defining or expressing inequality than in creating it. For the ancient Maya, jade was unquestionably a commodity with recognized value. However, as individuals were able to survive without jade (and most did), it must be viewed as a resource with social value rather than

one with natural value. Although jade was an important sumptuary commodity widely used in the symbolic, outward expression of authority and wealth, there is no indication that the hierarchical structure of Maya society rested solely on elite possession of jade (Freidel, et al. 2002). In fact, jade is not a ubiquitous element of elite burials, and many other materials apparently functioned as markers of status and wealth in an equivalent fashion (Freidel 1990; Moholy-Nagy 1997; Freidel et al. 2002; Saunders 1994). Jade was a vehicle used to define social inequality at consumer localities, not one used to create it. Most exotic goods operated in this capacity throughout the lowlands. An exception to this rule exists where resources with natural value are scarce and must be imported, as was the case with salt in many areas of the lowlands (cf. Andrews 1980). Social value is a cultural construction, and the value of resources whose significance is primarily defined socially may vary sharply between cultures – as observed in the contrast between the Maya and Spanish view of gold.

Economic Models

The capacity for developing valuable resource surpluses is a central feature of the political economy. Surplus resources are necessary for supporting material and labor investitures in public works projects and infrastructural improvements (Earle 1998:89; Childe 1951; Steward 1960). For the Maya, such efforts often included increasing the productivity of the commons by constructing agricultural terraces or channelized fields, or enhancing transport efficiency by constructing *sache* networks. Beyond supporting communal projects, however, surplus wealth, when differentially accumulated, engenders distinct patterns of resource distribution and consumption in domestic contexts, enabling distinctions between those who are socially elite and those who are not. In stratified societies, it is evident that some individuals and groups consume more human and material resources than others. What is not immediately evident, or anyway is not uniformly expressed, is the endogenous means by which these consumption disparities become manifest and justified. For this archaeologists turn to economic models.

Hirth (1996) has provided an excellent review of political economy models in the archaeological literature. The application of these models to the ancient Maya is discussed in depth further on in this chapter. According to Hirth (1996:209), archaeological models addressing the finance structure of political economies can be classified as production-oriented, service-oriented, or exchange/distribution-oriented. Based on the logic of their definitions however, only production-oriented and exchange/distribution-oriented strategies have anything to offer the development of stratification, while service-oriented strategies are more relevant to issues of maintenance (Table 1). The most staunchly advocated of production-oriented and exchange/distribution-oriented models rely on a system of resource mobilization.

Mobilization models depict systems in which elites accumulate human and material resources for which they return few if any benefits to the providing community (Hirth 1996:216). There is often an assumption of innate indebtedness within such models that places a relative moral burden on individuals and groups according to their position within a socio-political hierarchy. Elites receive tribute from commoners because they are elite. Thus, tribute flows upwards through this hierarchy in the form of labor and commodities, providing elites with a disproportionate resource base that enables and perpetuates inequality. While such relationships are unquestionably found in societies both past and present, the foundation on which many mobilization arrangements are justified is too often ideological, tending to ignore or overly generalize the material basis on which exploitative relationships are developed. This is more often the case when models center on the maintenance rather than the development of political economies. In the logic of ideologically driven mobilization models, tribute flowing from commoners is only secondarily an economic process; ideologically sanctioned differences in perceived intrinsic station are its primary *raison d'être*.

Adopting an approach that is overtly materialist, but subtly ideological, Earl (1998:89) asserts that the mobilization of resources which ultimately support the political economy “requires institutions to control human labor, and the simplest and most direct means to do this is through a system of land tenure that designates

productive lands as chiefly property.” Earle does not, however, provide a mechanism by which such a designation is socially justified. His argument relies on the existence and acceptance of an ideology that legitimizes the usurpation of property, justifying the right to command commodities in exchange for use-rights. The principle of first occupancy and the use of military force each provide plausible mechanisms through which political strategies for labor and material mobilization may be justified.

Table 1: Archaeological models of political economy (after Hirth 1996).

FINANCE MODLES	ATTRIBUTES
<i>Production-oriented Strategies</i>	
Intensified Domestic Production	Households and corporate groups increase the production of resources. Surplus in excess of subsistence needs is used to enhance claims on external commodities. This strategy of aggrandizing is heavily reliant on the ambitions of individuals, and is not likely to result in institutional inequality.
Assigned Production	Non-elites realize a moral obligation or are coerced into contributing labor to elite enterprises, including subsistence production, surplus production, craft manufacture, and public works projects. Elites have no claim to the domestic production of non-elites.
Hydraulic Management & Production Control	The coercive power of elites is founded on their control over the technology of production rather than land or labor. Hydraulic management is based on monopolizing the working knowledge or mechanics of irrigation systems. Elites perform managerial functions. Finance systems based on hydraulic management may also incorporate assigned production.
Controlled Craft Specialization (Wealth Finance)	Elites hold exclusive rights to production of particular craft items, which non-elites must acquire through exchange. Craft items may be of natural or social value. Exclusivity is maintained through alienating non-elites from either the technology of production or the right to exploit requisite resources. Patron-client relationships are likely to develop. Artisans may be supported by elite patron or may be elite themselves. Typical within wealth finance systems. Institutional inequality is more likely to be maintained than produced by controlling craft production, and efficacy of strategy may be undermined by subaltern resistance.
<i>Service-oriented Strategies</i>	Commoners provide elites with labor and resources in exchange for immediate services, such as healing or settling disputes. Resources are not provided for general services or out of general, pervasive obligation. Such finance strategies may not provide generational stability, and are not likely to lead to institutional inequality.

Table 1 continued:

FINANCE MODLES	ATTRIBUTES
<i>Exchange/Distribution-oriented Strategies</i>	
Elite Distribution	Elites manage the allocation of resources through administrative redistribution or monopolizing access to prestige goods. In the first instance, a primary finance system would have to already be in place to direct the flow of resources toward elites and sanction their discretionary re-allocation. Prestige goods are also unlikely to be the primary finance mechanism in political economies. They are more likely to function as a means to mark status rather than accrue it.
Interregional Exchange	The ability to manipulate trade with external resource areas may generate disparities in power, prestige and wealth at any stage of social complexity. External trade partners may provide insurance against crop failure, important military alliances, access to vital resources, and access to exotic luxury commodities. Functions as a form of finance so long as trade channels remain exclusive. Interregional exchange operates in conjunction with elite distribution, and may be based on resource and labor mobilization or strategic resource control. Such exchange may also develop into world systems linkages. This form of finance is central to peer-polity interaction and cluster or network analysis.
World Systems Linkages	World system linkages may or may not alter economic relationships within communities depending on the community's role in the overall system. Among other means, changes in the socio-economic structure of communities may occur through access to external markets and militaristic conquest.
Resource Mobilization Systems (Tribute Economies, Staple Finance)	The mobilization of tribute, whether in the form of labor or goods, characterizes a staple finance system. Elites collect resources from the domestic production of non-elites without a reciprocal counter flow. The exploitive relationship may be justified as an exchange for intangible services, such as elite providing commoners with protection from malevolent supernatural forces. Staple finance systems may develop endogenously as social ideologies transform through time and de fact inequality based on become formalized. Such systems also develop exogenously through territorial conquest and subjugation, and this may be more typical.
<i>Strategic Resource Control</i>	Access to critical resources is restricted based on property rights. Resources may not be wholly alienable, but their extraction requires compensation from those not endowed with natural use-rights. This inequitable distribution of use-rights results in a disproportionate flow of rewards toward the owners of the resource. Inequality thus structured is naturally legitimized and stable across generations so long as the resource remains viable and in scarce or regulated supply. Strategic resource control may underlie other forms of finance.

The principle of first occupancy, simply stated, asserts that the first residents in an area retain control over the allocation of its resources (McAnany 1995: 96). Images of early American pioneers racing across Oklahoma come to mind, but first occupancy was undoubtedly a complex process that initiated with the first settled villages in Mesoamerica. As more landscapes were permanently settled in the lowlands, catchment areas were alienated and fewer resources were attainable through open access. When kin groups became sedentary and devoted their energies into modifying local landscapes to provide a reliable subsistence base, their investment effectively privatized the landscape. Permanent architecture, landscape modifications, and lineage shrines to founding ancestors each substantiated this claim. McAnany (1995:97) implicates first occupancy property claims as the basis for later disparities in power, prestige and wealth, stating: “Although the principle of first occupancy sounds fair and equal, given time and the expansion of lineages this custom sets in motion a chain of events that inevitably results in pronounced *inequality* in access to resources.” Colonial period ethnohistory supports the realization of this principle among the Maya, offering that “lands today are common property, and so he who first occupies them becomes the possessor of them.” (in Tozzer 1941: 96-97).

The inequitable distribution of needed or otherwise desirable resources under first occupancy claims, over time, would have resulted in increased competition over productive lands. Lineages were almost certainly required to use aggressive force in consolidating and defending their dominance over valued property. However, militarism could also have afforded the disenfranchised a means by which to gain resource access provided they could unify (cf. Clastres 1977; Oppenheimer 1975). Mann (1986: 53-58) provides a more thorough discussion of the use of military force as a mechanism for acquiring control over human and material resources, and the reader is encouraged to consult this source for a broader treatment of this topic. For the Maya, however, there is little evidence to suggest that elites originated out of military subjugation, though substantial evidence suggests warfare figured prominently in the Byzantine geopolitics of the Classic period (Chase and Chase 1998; Martin and Grube 2000; Webster 1998,

2000). Based on archaeological data and contemporary ethnography among living Maya communities, normative rules of first occupancy are more likely to account for the initial establishment and distribution of use-rights over critical and otherwise strategic resources.

Strategic resource control, legitimized by normative rules of first occupancy, provides a conceptual model for observing the flow of resources in Maya society that is founded in material relationships rather than ideology. And these material relationships, which constitute the basal economic infrastructure for sustained inequality, are brought into clearer focus through the valuable insights provided by the welfare economics approach to modern liberal political economy. Furthermore, this perspective places equal emphasis on the rights and obligations of Maya elites and commoners alike. The greater entitlements enjoyed by some members of the community over others are less viewable as tribute than as a form of reciprocity. The labor of commoners was not necessarily owed to Maya elites simply because of their station as elites; political elites received *corvée* labor and the domestic produce of commoners in exchange for providing access to desired resources.

Welfare Economics

Defined by Barry Clark (1991:98), welfare economics is a subfield of modern liberal economic theory that is concerned with analyzing the conditions and institutions in a society which either provide for or impede the maximization of social well-being. Within the context of an ancient Maya community, social well-being best describes the ability of all members of the community to meet their minimal resource needs. The achievement of well-being reflects the flexibility of exchange relationships and the efficiency of social institutions in providing this minimal allocation of resources for all members of the community. Maximizing well-being involves accessing and consuming human and material resources beyond minimal needs, and to the extent that this was experienced differentially between individuals and groups, inequality can be said to exist. Markets provide a vehicle for the efficient allocation of resources, but can only

maximize well-being when the initial allotment of resources is optimized. In the view of welfare economists, central government is the dominant regulatory institution in society, and is responsible for providing the structural means to ensure an equitable pattern of resource ownership. The basis of inequality then rests in the way social structures divert resources from a commonly accessible pool and promote individual self-interest (B. Clark 1991:98).

The concerns of welfare economists go beyond minimal resource needs to deal with the social institutions which promote and maintain social inequality, observed in the varying levels of power, prestige and wealth enjoyed by some members of society over others. Sen (1992:20) states: “Liberties, rights, utilities, incomes, resources, primary goods, need fulfillments, etc., provide different ways of seeing the respective lives of different people, and each of the perspectives leads to a corresponding view of equality.” These perspectives are not, however, of uniform resolution in either current or ancient societies, nor do they necessarily affect well-being equally. Minimal resource needs were likely ensured in ancient Maya society through kin relationships and the inability of leaders to legitimately alienate people from their subsistence base (this point is readdressed in Chapter VI). Thus, the focus of this research is not on a measure of absolute deprivation, as in the ability for households to fulfill their basic resource needs, but on a measure of relative deprivation; the inequality observed in disproportionate levels of resource consumption. Consumption implies the ability to consume. And while the obverse is not necessarily true, I regard achieved consumption as an accurate reflection of consumption ability within the context of this research.

The Entitlements Approach

The *entitlements approach* advocated by Nobel prize-winning economist Amartya Sen (1981) introduces a vocabulary and framework for analyzing economies that renders the consequences of structural relations meaningful and immediately comprehensible, thus providing a useful model *for* reality (after Geertz 1973:93). Sen

(1981:45) developed the entitlements approach as a way to understand the systemic causes of famine, stating:

The entitlement approach ... concentrates on the ability of people to command food through the legal means available in the society, including the use of production possibilities, trade opportunities, entitlements vis-à-vis the state, and other methods of acquiring food. A person starves *either* because he does not have the ability to command enough food, *or* because he does not use this ability to avoid starvation. The entitlement approach concentrates on the former, ignoring the latter possibility. Furthermore, it concentrates on those means of commanding food that are legitimized by the legal system in operation in that society.

Famines result, according to Sen, not from the general unavailability of food, but from the absence of a legal means to acquire it (1981:43-45). Among living societies, famine represents an overt, measurable index of resource deprivation. The tenets of the entitlements approach, however, need not apply strictly to famines, but are applicable to understanding the causes and effects of deprivation in any critical resource. As I discussed earlier in this chapter, utilitarian lithic raw material and the tools produced from it were a vital resource as they were essential to the technological system on which the Maya economy was based. These resources are in finite distribution within landscapes and regions, with measurable differences in quality and quantity observable between outcrops. Thus, the environmental means were in place for utilitarian lithic resources to have been monopolized. The strategic potential of this resource is discussed in more detail below.

Scholars working in other areas of the world have demonstrated that differential access to economically important resources is fundamental to the development and maintenance of social stratification in complex chiefdoms and incipient states (Earle 1991b; Fried 1967; Johnson and Earl 1987; Kristiansen 1991; Sahlins 1972). As yet, the potential for local lithic raw materials to have factored in promoting and maintaining social inequality among the Maya has not been adequately explored, though some scholars have questioned elite control over specialized production (Hirth 1996; King 2000; King and Potter 1994; Lewis 1995). By adopting Sen's entitlement approach to the archaeological case presented at Blue Creek, the initial, inequitable allocation of

resource use-rights can be shown to have a significant effect on subsequent expressions of social inequality. If the legal means to directly obtain utilitarian lithic materials was not observed uniformly by all members of the Blue Creek community, the relative deprivation of these resource use-rights would have directly influenced the development and maintenance of social, economic and political hierarchies.

Endowments and Entitlements

Applying Sen's entitlement approach to the ancient Maya is contingent, to a degree, on how property rights were conceived. This is discussed in more detail below. However, two concepts are immediately relevant: *endowments* and *entitlements*. The productive, *convertible resources* an individual or corporate group has for their discretionary use is recognized as their *endowment*. Convertible resources are those which may be used productively in generating other resources, such as labor, fertile soil, and staple raw materials. They are resources with natural or social value (discussed above). If the economic needs of such parties are not satisfied through their endowment, the required resources must be obtained through reciprocal exchange. Toward these ends, labor or surplus domestic production may be converted. Corvée arrangements, where the use-rights to subsistence plots are allocated in exchange for labor and goods, provide a practical example of this scenario (Earle 1998:89; Costin 1991). The available resources individuals and groups may choose to acquire through such exchanges defines their *exchange entitlement*.

An entitlement is composed of resources that people have the legal means to command (Sen 1981). This includes resource use-rights. Where productive surpluses may be exchanged for alternative commodities, the entitlements of an individual depends on their initial endowment and their *exchange entitlement mapping*, being "the function that specifies the set of alternative commodity bundles that the person can command respectively for each endowment bundle" (Sen 1981: 45-46). Entitlements may vary between individuals more in amount than in kind based on the structure of

property ownership, with the various kinds of entitlement described by Sen (1981:2) as follows:

Entitlement relations accepted in a private ownership market economy typically include the following, among others: *trade-based entitlement*: one is entitled to own what one obtains by trading something one owns with a willing party; *production-based entitlement*: one is entitled to own what one gets by arranging production using one's owned resources, or resources hired by willing parties meeting the agreed conditions of trade; *own-labour entitlement*: one is entitled to one's own labour power, and thus to the trade-based and production-based entitlements related to one's labour power; *inheritance and transfer entitlement*: one is entitled to own what is willingly given to one by another who legitimately owns it.

These basic entitlements were almost certainly enjoyed by all individuals and groups within Maya communities, but not to the same degree. This is to say that inequality among the Maya was based on relative deprivation rather than absolute. "Relative deprivation" objectively describes a condition within a society where there is an uneven distribution of some desired attribute, such as resource use-rights or the ability to command tribute in exchange for such rights (cf. Wedderburn 1974). Slaves, as are known to have existed among the Maya, may constitute an important exception to this assumption of basal entitlement and relative deprivation (Tozzer 1941:63, n.292). In general, however, I believe that inequality among the Maya can be better understood through the differences individuals and groups experienced in the nature of their endowments and value of their entitlements.

Increasing the size of the domestic unit increases the endowment of the group as it provides more available labor. The convertibility of this labor, either directly or in the form of increased domestic production, provides a more valuable exchange entitlement. In fact, disparities in wealth observed among peasant agriculturalists within state-level societies typically result from the expansion of household production in excess of immediate needs (Hirth 1996:210). Some households among small-scale farmers have been observed to intensify domestic production as a risk-management strategy, in accordance with perceived or anticipated needs, or based on entrepreneurial desires (Netting 1990, 1993). For the Maya, ethnohistoric sources state that peasant farmers

stored surplus cash crops in “fine underground places and granaries” so that they could be periodically exchanged at market for other commodities (Landa in Tozzer 1941:96)

Researchers have speculated that surpluses generated by intensified domestic production establish the basal foundation on which social inequality is predicated (Hirth 1996:222). However, I question the durability of inequality generated by these means. Social stratification is not likely to result from increased domestic production as this strategy for generating greater productive capital is based on the entrepreneurial desires and efforts of single individuals whose ambition and social circumstances are unlikely to exhibit generational stability. It is only through institutionalizing differential access to economically productive resources that consistent differences in power and influence become stabilized within a society.

Capabilities and Freedoms

The entitlement approach within welfare economics emphasizes the contrastive distribution of *freedoms* and *capabilities* within a society, viewing these as the basis for social inequality (Sen 1981, 1992). Freedoms are defined as the real opportunities individuals have to pursue their goals (Sen 1992:31). Archaeologically, the actual freedoms and prohibitions individuals realized are difficult to address, particularly in the absence of codified rules such as the sumptuary laws enforced by the Aztecs (Smith 1996:53). Comparing the realized accomplishments of individuals, their *achievements*, does not provide an adequate means to evaluate freedoms (Sen 1992:38). For example, the lack of jadeite in a non-elite context would not necessarily mean that the household lacked the opportunity to attain jadeite, such as would be the case if sumptuary restrictions were enacted. Its absence may simply reflect deficient means. Luxury goods, such as jadeite, should indeed be rare in domestic contexts where exchange entitlements provide for little more than subsistence needs.

Capabilities and *functionings* describe the things that you have the legal and economic means to attain through entitlement (Sen 1992: 39-40). Functionings are the actual choices made and the resulting conditions of existence. Capabilities refer to the

set of all feasibly achievable functionings allowed by *freedoms*, and is thus a measure of the freedom to achieve well-being (Sen 1992: 40). Individual choice is recognized through capabilities and functionings. Whatever architectural style, pattern of personal adornment, diet, or inventory of materials an individual has, to some extent, represents a choice between alternatives, and each set of alternative “beings and doings” defines a separate functioning (Sen 1992:39).

The ability to achieve specific functionings is a relative measure of the freedom one has to achieve well-being. For the Maya, it’s relevant to consider, as some authors have, whether Classic period commoners had the freedom to exploit the same dietary sources as elites, specifically with regard to hunting deer (Carr 1996; Pohl 1985). Such dietary sanctions were common among feudal states of the Old World, substantially restricting a peasant’s freedom to achieve well-being through enjoying a healthy diet. Contrasts between individuals and groups vis-à-vis their ability to acquire goods through trade and mobilizing labor on their behalf may result from the differentially endowed right to develop and exchange productive surpluses. Equalizing resource access may not equalize substantive freedoms where there exists a significant discrepancy in conversion rights (Sen 1992: 33).

When all property is held in common and resources may not be alienated, substantive differences in the nature of endowments and entitlements are not likely to exist. If all members of the Blue Creek community enjoyed unrestricted use-rights to economically vital resources as part of their endowment, procuring such resources would be a shared entitlement, and the ability to procure these resources would have no direct impact on *exchange entitlements*. However, if direct access to such resources was not enjoyed equally by all members of the community, as would be the case where resources were owned more or less privately rather than communally, than obtaining these resources would decrease the *exchange entitlement* for those whose *endowment* did not include their free exploitation. The inclusion of direct resource access within an individual’s or corporate group’s *endowment*, where this right was disproportionately realized, would have enriched their *exchange entitlement* by two means. First, the actual

“cost” realized in attaining these resources is relatively low. Secondly, use-rights could be granted to those deprived of them in exchange for human and material resources. Ethnohistoric sources lend support for this scenario in stating that the perquisites of nobles included exemption from paying tribute and the right to receive food and gifts from those of lower status (Tozzer 1941:62, n.292). Enriched exchange entitlements may be observed archaeologically through greater domestic consumption of non-essential commodities, being those items which may ultimately define economic stratification between individuals.

An obstacle to substituting lithic resources for food is that dietary needs are less idiosyncratic. All humans require a given level of nutrition (calories), but tool requirements may be largely dependent on range of tasks and level of specialization. I justify this substitution through recognizing that among the Maya, stone tools were critical for procuring and processing dietary items, and were equally vital to other important activities that defined and supported the Maya lifeway. Also, I limit the bias introduced by task variability and specialization by measuring the percentage of local vs. non-local material represented in any context rather than measuring the actual number of tool forms and debitage from each source. The advantages of this approach are further discussed in Chapter VI.

The Development of Stratification from Rank

The argument that the unequal distribution of use-rights to specific resources provided a greater economic advantage to some members of society and not others hinges on several important assumptions. First, the argument assumes that there was in fact an unequal distribution of use-rights. Secondly, in order for resource monopolies to have acted strategically in this way, a means to enforce access limitations must have been in place. Thirdly, an ideology sanctioning the disproportionate appropriation of resources and inequitable accumulation of wealth would have to have existed. And finally, a process by which resource claims could be converted into the material indices of wealth would have to exist.

The Unequal Distribution of Use-rights

The development of differential resource entitlements is commonly observed among tribes and chiefdoms, and is most often socially regulated through kinship and lineage relationships. The emplacement of such regulations may serve to increase the overall efficiency of resource procurement, processing, distribution, and consumption, but it does not often function as a means for individuals to accumulate productive surpluses. Indeed, one of the great mysteries of social evolution is how the authority to regulate the use of resources as a means to increase productive and distributive efficiency, and to ensure the long-term viability of the system, was transformed into a means to monopolize resources for personal gain.

As Mann (1986:69-70) notes, there is no general model of social evolution that adequately explains the transition from ranked society, in which leaders are endowed with variable levels of authority, to stratified society where the power of leaders is formalized, coercive, and absolute. This transition results from local circumstances that must be elucidated and understood within the context of culture history. Within ranked societies, competing and overlapping spheres of authority exist between elders, lineage heads, bigmen, and chiefs such that no source of influence is absolute and individuals voluntarily comply with the demands of ranked individuals so long as doing so is perceived to be in their best interest. This choice of authority network, according to Mann (1986:69), “undermined the emergence of the social cage represented by civilization, stratification, and the state.” There were many more avenues leading away from social stratification and the institutionalization of coercive power than there were leading to its manifestation, yet stratification did emerge in the Maya lowlands. The great challenge is to discover the particular mechanism or set of specific circumstances that gave rise to it. This study is limited to testing whether or not critical resources were in fact dominated by Maya elites at Blue Creek, Belize, examining the institutions through which the strategic management of such resources resulted in the unequal distribution of wealth and status.

The Means to Enforce Alienation

David Webster (2000) has compared two general models of socio-political organization for the Maya, each having distinct implications for the nature and degree of elite power and the economic structure of communities. In his “kinship model”, elites would have been little more than stewards over productive resources and kin relationships would have connected all people socially regardless of their economic class. Within this model commoners are provisioned with resource use-rights as sanctioned through the kinship ethic. This ethic structures and legitimizes reciprocal obligations between commoners and elites. Real differences in the capacity for accumulating power, prestige, and wealth remain, however, regulated by the relative position individuals hold in descent groups (Marcus 1993:131; Webster 2000: 181). This contrasts the “stratified model”, wherein elites effectively own and manage all productive resources (Webster 2000:181). Within the stratified model, commoners were not naturally endowed with resource use-rights, but were granted them by rulers in exchange for claims to their surplus production or labor. The coercive power of elites was thereby used to politically marginalize commoners and alienate them from the means of production.

While obligatory tribute payments provided an effective means by which rulers could develop productive surpluses, it is important to consider that social elites entitled to such tribute may have been obliged to reinvest these goods (partially or wholly) into the community. Such reinvestment could have taken several forms. Those that immediately come to mind are storing surpluses to compensate for the disparity between supply and demand in periods of resource shortage, using surplus as an exchange commodity by which exotic goods were obtained and made available to the local community, and using surpluses to fund socially valued activities and enterprises such as festivals, ceremonies, public works projects and infrastructural improvements, and warfare. In such a scenario, obligatory distribution or redistribution of important commodities may have been a function of elite office. However, the obligations of elites are often not without their rewards. As observed by Scott:

The generosity enjoined on the rich is not without its compensations. It rebounds to their growing prestige and serves to surround them with a grateful clientele which helps validate their position in the community. In addition, it represents a set of social debts which can be converted into goods and services if need be (1976: 41).

Essentially, differential access to resources was likely realized whether resources were privately managed by coercive rulers or communally managed through kin relationships, but the presence and character of leveling mechanisms needs be considered when evaluating the extent to which differential access contributed to socio-economic stratification. Webster (2000:185) concludes that data gathered from archaeological investigations at Copan provide stronger support for the kinship model at that site, though the fit of such models should not be assumed and must be tested on a site-by-site basis.

These two models do not represent the sum total of all possible permutations of Maya social organization, but they provide a convenient dichotomy by which site data may be evaluated. Importantly, each presents a means by which individuals may express varying levels of power, prestige, and wealth. There is no evidence to suggest that Maya rulers exercised totalitarian rule, and they are certainly not likely to have been able to enforce absolute alienation from critical resources. Given the tendency for oppressed Maya laborers to escape their oppression by disappearing into the jungle during the Colonial period (Reed 1964), it is not very likely that Maya commoners in the Classic period considered themselves overly exploited. The centripetal tendency for Maya commoners to aggregate around urban centers was almost certainly accomplished through perceptions of self-interest rather than coercive force.

Scott (1976) suggests that commoners in pre-capitalist societies were more likely to have measured their level of exploitation not by the amount to tribute exacted by elites, but by their ability to meet domestic and security needs with the resources they were left with. This may perhaps address a middle ground between the kinship and stratified models discussed by Webster. The distribution of resource use-rights may not have been equitable between elites and non-elites, but this basal inequality was

sanctioned and legitimized by the obligations elites had to protect commoners from risk and uncertainty. In this scenario the legitimacy of leaders was based on what Scott calls the subsistence ethic, whereby elites were responsible for providing commoners with the necessary means to meet their minimum resource needs (1976: 41). This may have entailed arranging the importation of scarce commodities from external resource zones, such as at Blue Creek where the viability the site's economic base relied on importing large numbers of stone tools. Whether this was accomplished through the efforts of Blue Creek's elite or through more systemic forces will be discussed in the chapters that follow. Regardless, commoners may have voluntarily acquiesced to the tributary demands of elite, however exploitive, so long as they were left with the means to meet their minimum resource needs, and so long as they were satisfied in the ability of elites to provide them insurance against critical resource shortages.

Ideological Sanctioning of Resources Appropriation and Wealth Accumulation

The inception and endurance of social hierarchies is contingent on the development of an ideological structure that justifies and legitimizes the unequal distribution of power, prestige, and wealth between individuals and groups (DeMarrais et al. 1996; Hirth 1996:225; Mann 1986). Social ideologies reflect the world view on which the behavioral norms governing resource ownership, end usage, and the freedom to convert resources into other forms of capital are legitimized and perpetuated. Elite ideologies may promote "a sense of common identity while they justify social differences and unequal access to wealth and authority" (DeMarrais et al. 1996). Popular acceptance of elite ideologies necessitates the internalization of elite values by non-elites, a process promoted through visual representations of the ideology's symbolic system. The physical, public portrayal of an ideology's central elements and themes facilitates its dissemination while reinforcing and objectifying its canons. Segments of a population able to tactically control public, material portrayals of their values and interests may establish and legitimize collective conceptions of equity and morality to their own advantage.

Pre-state societies are not immune to inequitable resource appropriations on the part of ambitious individuals or corporate factions. Bigmen and chiefs may aggregate surplus resources within the context of gift giving or in accordance with their redistributive responsibilities, but the accumulation of conspicuous displays of wealth by these leaders is seldom sanctioned. The authority of such leaders often rests on their adherence to a moral contract requiring them to act for the benefit of society, and is thus seldom coercive (Clark and Blake 1994; Johnson and Earle 1987). The authority of bigmen and chiefs, and the amount of support they enjoy, is secured by acts of generosity that inhibit the accumulation of wealth by individuals, or else make them undesirable. The ideological structure of such societies works to maintain an egalitarian ideal. This ideal of egalitarianism, as noted by Scott (1976: 40), is more often conservative than radical, insuring only that “all should have a place, a living, not that all should be equal.” However, even if objective differences in authority and economic capability exist, no one may be alienated from their resource base, and disproportionate entitlements are only socially justified to the extent that they “are employed in ways which meet the broadly defined welfare needs of villagers” (Scott 1976: 41). A critical factor in the development of social stratification may then be the ability to transform or circumvent social ideologies which promote the egalitarian ethic, and this necessarily entails a re-conceptualization of property. To understand how such transformations in normative conceptions of property are institutionalized, it is important to first establish the set of relationships that are to be contrasted.

Earle characterizes the nature of use-rights vis-à-vis property as either open access, commons, fief, or private (Earle 1998: 91). Formal rules governing the right to use a resource conceptualized as open access property do not exist. Everyone, regardless of group or intra-group affiliation holds an inalienable entitlement to utilize open access property. Use-rights to property held in common are inherited through the socially negotiated arrangement of reciprocal entitlements and obligations that are often influenced by kinship structure. Use-rights to property incorporated within a fief are allocated by its owners to those not otherwise entitled to its access. Users maintain

exclusive entitlement to their allotments in exchange for economically and politically supporting the fief's owner. The resultant patron-client relationships may or may not be exploitive. Private property is defined as property that may be legally alienated, and owners are under no moral obligation to grant use-rights to others within their community. The entitlement to use may be transferred to another party, with the original party yielding all claims on the property. Rules governing the ownership of property exist in all societies, and are a fundamental consideration for understanding patterns of resource distribution. Cross-cultural differences exist in the criteria that distinguish common property from private property, with the distinction often dependent on the nature of the resource. Colonial documents make it clear that the Maya recognized both communal and private property. The Chi Manuscript in particular explicitly states that:

lands were in common and (so between the towns there were no boundaries or land marks to divide them) except between one province (and another because of wars), and in the case of certain hollows and caves (plantations of fruit and cacao trees, and certain lands (which had been purchased for the purpose of improving them in some respect) (Chi Ms. In Tozzer 1941:96-97, n.429).

This passage suggests that the Maya, at least during the Colonial period, made a distinction between basic subsistence resources that were regarded as common property and luxury commodities that could be privately owned. Within pre-state societies, resources essential to the economic well-being of the group are typically conceived as common property, and normative institutions prohibit the monopoly and alienation of these resources (cf. Wiessner 2002).

Some researchers have speculated that the strategic generation of surpluses that allowed individual accumulations of wealth and power derived not from the control of basic food resources, but through new institutions from which the access to and distribution of exotic resources could be monopolized (Hirth 1996:218-219; see also Dalton 1977; Hirth 1992; Renfrew and Cherry 1986; Schortman 1989). In prestige good economies, for example, elites procure high value status commodities from external source areas and control their distribution within the local community (Hirth 1996:216). Developing this argument, Hirth (1996:208) adds the following:

luxury items were crucial for developing, defining, and expanding both regional and supraregional political networks. The exchange of luxury items functions to define the networks of social identity among elites, supply a network through which staple goods may move, and provide a network for mutual assistance and social alliance.

One of the weakness in this argument for explaining the initial development of stratification, as it is constructed by Hirth, stems from its inability to provide a mechanism by which exotic goods are acquired. The first part of the argument is undermined if we assume that they were acquired through balanced exchange, as elites would have had no initial rights to accumulate local surpluses for exchange capital. Tactical management of prestigious, exotic resources is a more plausible mechanism for maintaining stratification that generating it.

Wiessner's work among the Enga better illustrates a scenario for the social sanctioning of wealth disparities. According to her research, inequality was permitted because it was generated through new institutions that did not threaten existing ties between individuals and their means of subsistence (Wiessner 2002:248). The introduction and development of these new institutions, according to Wiessner, need not have been a matter of chance, but may occur through a series of rational choices made by entrepreneurial individuals. Ambitious leaders tactically promoted certain innovations they believed would provide them with the greatest personal rewards. However, only those perceived by the group to be in their collective best interest were eventually institutionalized (Wiessner 2002:251). Among the Maya of the Formative period, normative rules of social behavior may have limited the alienability of critical staples. The beginnings of formal stratification may then have been reliant on the introduction of new institutions that could be advantageously monopolized by individuals. In this regard it is interesting that prestige goods such as *Spondylus* shell, cacao, and jadeite are either first introduced or begin to flourish during the Late Preclassic period, precisely when vast discrepancies in the claims individuals hold over human and material resources emerge across the Maya lowlands (Freidel, et al. 2002).

Political economies require both a mechanism that facilitates the uneven distribution of access rights to productive resources, and an ideology that legitimizes this relationship (cf. Hirth 1996:209). The processes by which these features develop are not clearly understood, and are unlikely to be explained through general principles of social evolution (Mann 1986). What is important to this study is that the opulence of Maya elites, whether based on the extraction of tribute from an essentially autonomous hinterland population or the inequitable distribution of resource entitlements, was ideologically sanctioned. Rulers depicted themselves as the emissaries, companions, and embodiments of powerful deities, and in this capacity they provided for and protected the economic and spiritual livelihood of the masses.

Converting Resource Claims into Wealth

For the Maya, expressions of wealth and capability take one of two general forms. The first is explicit, the second implicit. Archaeologists often distinguish Maya elites through the relative extravagance of their furnishings and the grandeur of their residences (Chase and Chase 1992; Guderjan, Lichtenstein, et al. 2003; Inomata and Houston 2000). These explicit, material expressions of ability attest to the greater entitlements elites enjoyed in mobilizing resources toward the enrichment of their personal well-being. Implicitly, this mobilization of resources attests to the claims elites held over the labor of others. Elite opulence is then a measure of both their accumulated material holdings and the labor investment that supported it. The question we must then ask is this: by what means did elites acquire their wealth? I have already discussed how social inequality was made possible by the disproportionate distribution of human and material resource entitlements, and I turn now to the means by which resource claims were converted into other forms of capital.

Archaeological models commonly attribute incipient economic and political development to intensification of domestic production, mobilization of labor and assigned production, hydraulic management and control over production, and complete or partial control over craft manufacture (Hirth 1996:210). Hirth particularly contrasts

models advocating resource mobilization with those favoring labor mobilization, or assigned production, stating:

By assigned production I am not referring to a system whereby a certain proportion of the crop produced within normal household subsistence activities is allocated to community use. This would correspond to a taxation or resource mobilization strategy. Instead, surplus is created by mobilizing labor, not commodities, from individual households. (Hirth 1996:211)

Hirth favors assigned production, the right to command labor rather than material resources, as the fundamental strategy used by elites to create and accumulate productive surpluses in New World state societies (1996:211-212). In assigned production, commoners contribute labor toward the development of productive resources on the lands of the elite, participate in public works projects including the construction of administrative buildings and transportation infrastructure, or engage in other endeavors sanctioned by nobles, but are not taxed a portions of their domestic produce. Assigned production is observed among the Maya, to a degree, within ethnohistoric accounts. For example, Landa notes that it was the responsibility of Maya commoners to construct the residences of elites (Tozzer 1941:86). Assigned production is based on the moral or legal obligation elites impose on commoners that requires them to invest labor into developing land annexed from the commons (Hirth 1996:211). Resources harvested from this annex are exclusively managed by leaders. And while they may ostensibly be intended to support social needs, as with the storage of surpluses for mitigating periodic resource shortfalls, or through using surpluses to draw import commodities into the community, these resources may be advantageously used by elites to improve their own well-being.

The assigned production model advocated by Hirth has exceptional utility in explicating the means by which claims over labor could be converted into capital, but I do not believe that it sufficiently embraces elite accumulation strategies. One attribute of the assigned production model works particularly well; elites are not likely to have held claims over the domestic production of non-elites. The assigned production model falls short, however, by dismissing the role of material tribute. Ethnohistoric accounts are not vague in their description of the tributary requirements of peasants:

Beyond the house, all the town did their sowing for the nobles; they also cultivated them (the fields) and harvested what was necessary for him and his household. And when there was hunting or fishing, or when it was time to get their salt, they always gave the lord his share (Landa in Tozzer 1941:87).

The above passage indicates that commoners were in fact obligated to devote their labor toward provisioning elite households, which accords well with the assigned production model. However, counter to the assigned production model, it also indicates that the tributary entitlements enjoyed by elites included material resources such as fish, game, and salt. Accumulation strategies used by Maya elites appear to have incorporated both assigned production and resource mobilization. I believe that both these strategies can be explained through the monopolization of strategic resources. Through annexing property from the commons, legitimized through either the principle of first occupancy (McAnany 1995:96-97) or realized management needs, Maya elites manipulated the availability of critical or otherwise strategic resources. In this scenario, control over access could have been based on either the tactical management of use-rights or control over craft production (cf. Clark and Parry 1990; Helms 1993; Hirth 1996). Elites provided commoners with the means of acquiring needed resources, validating the flow of labor and material tribute. A further passage from Landa may confirm this relationship. He states that salt could only be harvested from the rich beds of the Yucatan after seeking permission from the lords residing over the general territory “who had the most right by proximity” and paying them some offering of either salt or an alternative commodity (Tozzer 1941:189)

Measuring the Basis for Inequality

Many resources may have been tactically administered by Maya elites to develop, maintain, or augment the inequitable distribution economic rewards. As noted by Hirth (1996:206), “the economic basis of enduring political systems is rarely based upon a single resource or economic relationship; rather, they are based upon a mix of economic activities that are geared to expropriate an array of resources for use in the sociopolitical arena.” While this may be accurate, not all such resources or economic

relationships provide archaeologists with the same level of resolution. Agricultural resources may very well have been monopolized by the elites of Blue Creek, but there is no material evidence for such a relationship. Colonial period ethnohistories and comparative ethnography provide only speculative evidence to support such claims. Simply, the potential visibility of resource extraction, distribution, and consumption in the archaeological record is not uniform for all commodities, and the ability to observe these processes ultimately depends on the preservation of both the resource and its associated economic behaviors.

In terms of economic tasks and behaviors, stone tools and the material waste derived from their manufacture and use are better preserved archaeologically than are perhaps any other strategic resource. A particularly dynamic aspect of utilitarian lithic resources, given their fundamental importance and irreplaceability, is the fact that they are non-renewable. There is no way to create more of this resource which exists in finite supply, so shortages (defined as the failure for supply to meet demand) must have been realized in many areas, either initially or over time. This offers researchers a tremendous opportunity to study the ways in which synchronic and diachronic differences in resource availability within and between sites affected socio-economic and political relationships.

The ability to source lithics is of great benefit to archaeologist in reconstructing past economies as it directly relates to economic realities within and between sites. The sourcing of particular cherts to the northern Belize chert-bearing zone has been instrumental in defining producer consumer relationships within and outside the northern Belize region (Hester and Shafer 1991; Santone 1997; Shafer 1985; McAnany 1989; Dockall and Shafer 1993). Also, the discovery of viable raw material sources can also help in locating production areas. The organization of production at manufacturing localities may also provide information on inter-polity dynamics.

Differences in economic function may also be observed within and between sites. McAnany notes that consumer sites tend to exhibit varying subsets of Colha exports, which she attributes to functional considerations (1989). Degrees of resource recycling

may provide information relating to either the scarcity of utilitarian lithic resources in the site's catchment area, or to contrasting economic burdens different residences experienced in the acquisition of such materials. Shafer has noted significant differences in material recycling between production localities and consumer areas, showing a tendency toward conservation where utilitarian lithic resources are in scarce supply and high levels of waste where materials are in abundance (1985). Along these lines, McAnany observed that imported cherts tended to be more heavily recycled than local chalcedonies at Kaxob, reflecting both the scarcity of quality raw materials at the site and differences in the productive potential of each material (1989).

Lithic analysis may provide one of the most fundamental and productive avenues for studying Maya social and economic organization. Utilitarian lithic raw materials are in heterogeneous distribution throughout the Maya lowlands, and the inherent mineralogical variability that characterizes this resource often allows for the detection of specific procurement zones. This, together with the fact that stone tools formed the technological core of the Maya subsistence economy, produced a continuous demand for the resource that mobilized its distribution in an observable fashion. Further, the procurement, processing, distribution, consumption, and discard of lithic materials produce distinct and discernible features that allow researchers to distinguish the dynamic patterning of these economic behaviors in the archaeological record. Finally, stone tools and debitage are typically the best preserved artifacts in archaeological contexts, and they are in ubiquitous distribution at sites in the Maya lowlands. The analysis of locally available utilitarian lithic resources provides perhaps the most unambiguous means to test whether or not critical resources were monopolized and tactically managed by Maya elites.

Ecology and Economic Structure

Early research focusing on the physical geography and climatology of the Maya lowlands offered invariably coarse-grained descriptions, suggesting that vast areas of the lowlands were composed of a homogenous set of environmental attributes. In reality,

however, natural resource inventories and their extractive potential varied substantially among lowland landscapes, producing an unbalanced distribution of economic advantages and limitations. An abundance of staple resources in one area provided the means for specialization and the development of export-oriented economies, while the absence or scarcity of staple resources in other areas provided the need for this specialization. Ultimately, a landscape's relative productivity or barrenness is only appreciable through the fine-grained analysis of its environmental heterogeneity.

Fedick has commented on the importance of understanding the diversity within landscapes at variable orders of resolution. He stresses that "differences in the local patterns of settlement and land use between two regions with land resources that appear similar at the regional scale may be explained in part by differences in land-resource structure that are evident only at the local scale" (1996: 339). By appreciating the heterogeneity landscapes exhibit at the local level, we may better understand the choices made by the ancient Maya with regard to managing, modifying, or monopolizing various resources. With this in mind I now define *landscapes* and *regions* as relevant fames of analysis, and discuss how their structural heterogeneity affects the expressive behavioral and material patterns of culture.

Landscape Ecology

The terms 'landscape' and 'region' are frequently used by archaeologists to distinguish between local and broad perspectives. There has been less frequent attention given to explicitly defining these terms, though this has recently begun to change. From the perspective of landscape ecology, these terms define scales of resolution by which geographic areas and their component elements can be distinguished and observed. Landscapes are defined by their unique combination of biotic and abiotic components, which result from patterns of substrate patchiness and connectivity, natural disturbance, and human activity (Forman 1995). Regions are "composed of a non-repetitive, high-contrast, coarse-grained pattern of landscapes" (Forman 1995: 134). Typically, regions are broad geographic areas with common microclimates and spheres of human activity,

in which a coarse-grained pattern of landscape tessera generates considerable ecological diversity (cf. Rice 1993; Graham 1987). Fedick (1996: 341) has observed that “while many land-resource types are common throughout much of the Maya lowlands, the ratios of these various resources vary quite a bit from subregion to subregion.”

Forman (1995: 135) states that “the arrangement or structural pattern of patches, corridors, and matrix that constitute a landscape is a major determinant of functional flows and movements through the landscape, and of changes in its pattern and process over time.” Maya inhabiting coastal areas relied more heavily on marine resources and aquatic modes of transportation, reflected in the construction of port facilities, use of coral rather than limestone in architecture, and the preferential consumption of marine species. In the flat wetlands of northern Belize, Maya practiced raised and channelized field cultivation, while Maya in the hilly landscapes of southern Quintana Roo, the Maya Mountains of Belize, and the Petexbatun region of Guatemala practiced hillside terrace agriculture (Turner and Harrison 1983; Dunning et al. 1998; Dunning 1992; Dunning and Beach 1994). Broad-scale observations of southern Mesoamerica may find their greatest utility in addressing spatial and temporal patterns of migration and settlement, explicating and contextualizing long-distance trade relationships, and addressing the geo-spatial character of expressive culture, but they are of little utility in understanding the idiosyncratic nature of human adaptation. Much of the diversity in cultural expression observed throughout the Maya lowlands is the result of local adaptation to landscape diversity.

Nature and Culture

Multiple lines of evidence suggest that landscape structure was a major influence on ancient Maya settlement decisions. The distribution of economic resources, especially arable soils, appears to have been a major determinant of settlement organization at the landscape level of analysis (Fedick 1996b: 128). Settlement along the fertile alluvial floodplain of the Belize River Valley existed prior to the artifice of elite domination, and appears to have extended well beyond it (Ford 1990). Santone

(1997: 71) has observed that “in most instances centers of production are situated in close proximity to the basic resources necessary to the industry.” The site of Colha in northern Belize, for example, provides evidence for extraordinary levels of stone tool production which supplemented consumption needs at numerous consumer sites (Hester and Shafer 1994; Shafer and Hester 1983; McAnany 1989b; Dockall and Shafer 1993). Further evidence that the differential distribution of economic resources affected Maya social organization is observed within the Maya Mountains area of Belize where sites exhibit a preferential tendency to be situated in proximity to resource procurement nodes (Dunham 1996).

Critical resource deficiencies may be implicitly observable through the paucity of settlements in resource-poor landscapes. In this regard, McAnany (1990) has shown that the remarkably deep water table in the Yucatan (40-90 meters below ground surface) precluded the construction of wells, such as have been found in other areas of the lowlands (Harrison 1993; Wilken 1987; Winzler and Fedick 1995). She offers that the dense settlement of the Puuc region was due primarily to the presence of soft bedrock that allowed for the construction of cisterns. Fedick (1996: 345) observed that “the availability of water has often been recognized as perhaps the most significant factor in the distribution of ancient archaeological sites in the Maya Lowlands.”

Landscape heterogeneity may have been the most important factor in for ensuring a population’s ability to successfully adapt and survive through periods of environmental stress, whether caused by anthropogenic or natural agents. Pendergast has observed that the environs of Lamanai are much more diverse than those of Altun Ha, with a greater number of readily available, non-redundant resources, (1986: 227). This likely contributed to Lamanai’s survival through the ninth- and tenth-century collapse suffered by most polities in the southern lowlands, including Altun Ha. A similar pattern is observed at Copan where house-groups in ecological zones having superior natural soil fertility and a greater potential for sustainable agricultural production exhibit the highest incidence of survivorship through the collapse (Paine and Freter 1996).

A Landscape Archaeological Approach

Due to the broadening focus of archaeological inquiry and advances in analytical technology, new research paradigms have begun to emerge. One such paradigm is *landscape archaeology*. Landscape archaeology is a holistic, multidisciplinary endeavor, with research drawing on recent advances in many complementary and often contrastive fields of study. Landscape paradigms are an outgrowth of regional-scale archaeological research focused on a cultural-environmental dialectic (Ashmore and Knapp 1999; Knapp and Ashmore 1999; Silbernagel, et al. 1997; Wagstaff 1987). This approach has been employed in addressing issues governing the manner in which human social, political and economic systems interact with, and are affected by, purposeful strategies of landscape management, and the opposing forces of entropy. The landscape perspective offers that a landscape, as a functional realization, is an all-encompassing concept that includes humans and their ideologies of structure and order, natural ecosystems, and the forces of opposition conceived through their interaction (Fisher and Thurston, 1999).

Fedick has expressed the importance of integrating principles from landscape ecology into landscape archaeological approaches, stating that “landscape archaeology can only be a viable approach in situations where the heterogeneity of landscape elements and their functions is realized” (1996: 339). Landscapes and regions are unique throughout the globe, but each is comprised of definable spatial elements that establish order and predictability in ecological systems. Recognizing these elements is a necessary first step toward understanding their functional interrelationships, and toward understanding the possibilities and limitations landscapes presented in the development of political economies. Resource management strategies display marked spatial and temporal variability across the Maya lowlands. Spatial diversity in economic structure was influenced by regional differences in landscape structure, techno-environmental influences, sub-cultural differences between regions, and site function. Temporal diversity in economic structure was influenced by demographic shifts, the waxing and waning of geopolitical influences, marked change in religious and political ideology,

external cultural influences, climatic change, and the dialectical influence of natural and cultural forces on the landscape.

The landscape archaeological approach is solidified through three unifying themes (after Fisher and Thurston, 1999). The first theme recognizes the existence of a dynamic, accumulative, humanly built and maintained environment. Humans groups then are not passive actors on a static natural stage, but continuously alter, and are altered by, their environmental setting. The second theme stresses that landscapes are the products of historical processes. The effects of natural and anthropogenic processes bring about transformations in landscape structure. Through systemic feedback mechanisms, landscapes, never static, represent a malleable dimension of material existence. The final theme addresses the continuous exchange of influences between humans and the natural environment. Neither natural nor anthropogenic inputs into the system necessarily take precedent in the metamorphic processes affecting realized landscapes. There is instead a perpetual balance of actions and reactions that inhibit stasis in either nature or culture.

The earliest landscape studies in the Maya lowlands focused on lowland physical geography, ecology and climatology (Escoto 1964; Stevens 1964; Tamayo and West 1964; Wagner 1964; West 1964), and how these characteristics affected aspects of human social, economic, and political organization (Bullard 1964; Cook 1947; Cowgill 1962; Dumond 1962; Linton 1962; Sanders 1962; Willey 1956). As mentioned above, the coarse-grained approach of these works significantly limited their utility. More recent studies have addressed the mosaic composition of landscapes and regions, the presence of road and wall networks, various methods of addressing political landscapes, and attempts to reconstruct sacred landscapes (Fedick 1996: 337). The research methodologies of Mayanists oscillate between materialist definitions influenced by Earth sciences such as geography and ecology (Dunning 1992; Fedick 1996; Rice 1993), and more cognitive definitions influenced by behavioral sciences such as philosophy and psychology (Freidel et al. 1993; Knapp and Ashmore 1999; Schele 2000). A thorough examination of materialist and idealist methodologies is beyond the aspirations of this

work. Throughout this work, however, I adhere to a materialist definition of landscape that puts a priority on geological structure and the arrangement of biotic and abiotic elements. Implicit in the materialist conception of landscapes is that humans, regardless of cultural ideology, would view any landscape as an area from which a particular set of natural resources may be exploited. This definition contrasts with Knapp and Ashmore (1999: 20) who state that “in pre-modern, non-Western societies, landscape may have been regarded as largely mythic space, but one in which humans actively participated.” While I believe idealist arguments may have great utility in fostering an understanding of a society’s aesthetic projection, the structural foundation of a society may be most fully understood through a recognition of the society’s behavioral modes of production and reproduction (after Harris 1979).

Features of Maya Political Economy

Several summary works concerning Maya subsistence economy and political economy have been published over the past few decades. These include Elizabeth Graham’s study on resource diversity in Belize (1987), Patricia McAnany’s discussion of economic organization in Belize, Marilyn Masson’s introduction to the recent edited volume on Maya political economy (2002), and Graham’s summary perspective on economic theory in lowland Maya research in that same volume (2002). Collectively, these works offer a valuable review and critique of methodological approaches and theoretical orientations vis-à-vis Maya economic organization and political economy. Additionally, there have been four edited volumes particularly notable for their substantive contributions toward determining the basis for and structure of Maya political economies. These include Pohl’s (1985) compilation on the subsistence economy of the Maya lowlands, the Chase and Chase (1992) volume discussing the nature of Maya elites, Fedick’s (1996) volume on mosaic resource distribution in the Maya lowlands, and the recent Masson and Freidel (2002) volume focusing specifically on Maya political economy. These works offer important data and insight on lowland resource heterogeneity, regional economic integration, and state finance systems.

A historic overview of archaeological studies of Maya political economy would be wholly redundant as the reviews offered by Graham, McAnany and Masson already provide excellent assessments of the breadth of relevant concerns and their development through time. As the current work is primarily concerned with the critical elements of Maya economies and the means by which state finance systems promote and maintain social inequality, I will limit my review to these topics.

The Critical Elements of Maya Economy

Developing a rich, fine-grained perspective on lowland resource heterogeneity is fundamental to understanding the basis of local economies and the structure of local, regional, and long distance exchange (Fedick 1996a; Graham 1987; Masson 2002). With this in mind, one of the most influential developments in recent decades has been the proliferation of research related to the distribution of staple resources across the lowlands.

For many decades, models of Maya political economy were constrained by the commonly held view that the Maya lowlands contain a generally homogenous distribution of economic resources (McAnany 1989a). From this perspective, local economies were largely redundant throughout the lowlands, providing no mechanism for the development of complex political structures, and no motivation for regional or interregional economic integration (Sanders and Price 1968; Tourtellot and Sabloff 1972). This coarse-grained view of lowland homogeneity was one developed by cultural and geographical outsiders from the modern world that, in retrospect, was never congruent with archaeological and environmental data. Artifact assemblages vary across the lowlands with regard to aspects of subsistence technology and the nature or intensity of resources exploited. This variation is primarily influenced by the capabilities and limitations afforded by local environmental conditions. Ceramic net weights, for example, are common to coastal, lacustrine and riverine sites, but scarcely found at sites in other environmental zones (Boxt 1993). Coastal sites also exhibit greater exploitation

of marine fauna (Hamblin 1984), as obsidian and granite are found in higher percentages at sites nearer the Guatemala highlands where these resources naturally occur.

Several recent studies have been instrumental in redefining the Maya lowlands as a mosaic amalgamation of landscapes characterized by an irregular distribution of finite economic assets (Dunham 1996; Fedick 1996b; Graham 1987; McAnany 1989b, 1990). This perspective is certainly a better approximation of how the Maya themselves perceived their world. It also provides archaeologists with both a recognizable set of conditions through which complex political and economic structures could have developed, as well as the motivation for regional or interregional economic and political integration.

The lack of sophistication in early archaeological descriptions of lowland Maya environmental variability and economic structure can be attributed, in part, to the absence of technological proficiency in the field of archaeology at the time (Fry 1980). Many scholars relied on early colonial accounts rather than actual archaeological data as the basis for constructing economic inferences (cf. Thompson 1966). Given these limitations, Frans Blom's *Commerce, Trade, and Monetary Units of the Maya* (1932) represents a notable early effort in its discussion of the heterogeneous distribution of economic resources and patterns of commercial exchange. In several instances, Blom infers that rather than being fundamentally self-reliant, Maya polities were dependent, to some degree, on the exchange of commodities between well-established resource zones. These inferences are congruent with the impressive distribution of resources (mainly in the form of objects rather than raw materials) away from their source areas. Blom also offered perhaps the most thorough, early description of ancient Maya economic infrastructure, though it lacks the scientific rigour of the sort developed in the 'new archaeology' of the 60s and 70s (Sabloff 1990). Addressing the logistics of trade, Blom (1932:548) states that "Trade moved over regular roads, crossing swamps and following mountain passes. The land trade was hauled on slave-back. Water trade was conducted in dug-out canoes, upon the rivers and along the coasts." Several authors have since made important contributions to the study of commercial exchange networks through

their examination of the regional infrastructure supporting overland trade (Chase and Chase 1998, 2001; Drennan 1984; Fedick, et al. 1995; Fowler 2001). In final analysis, however, Blom's work did not provide a fine-grained analysis of lowland resource diversity, containing several incorrect assumptions with regard to the availability and distribution of resource procurement nodes. Also, his work does not consider temporal variability in the dynamics of Prehispanic trade, which contrasted contemporary views that only attributed intensive trade to the Maya during the later Postclassic period.

Commodity Distribution

Archaeologists have recurrently addressed patterns of commodity distribution (McAnany 1989b; McSwain 1991; Santone 1997; Shafer and Hester 1991), with the greatest advances in this arena coming from studies of chert, obsidian, and ceramic artifacts due to their excellent preservation and the identification of production localities through visual or chemical sourcing (Cackler, et al. 1999; Foias 2002; Fowler 1991; Rands and Bishop 1980). The distance goods travel from production localities varies in accordance with the nature of transport, their general availability, and the nature and intensity of consumer demand. In general, goods travel further from their procurement or production zones when transported along waterways rather than overland (Santone 1997). Also, goods travel further when local alternatives are not available. This pattern is most observable with regard to commodities having prestige value, as witnessed by the broad distribution of jadeite (Freidel, et al. 2002; Guderjan 1998), chert eccentrics (Gibson 1986; Santone 1997; Shafer and Hester 1991), and marine shell (Andrews 1969). The prestige of these commodities may in fact be based on their exotic origin.

Finally, as this work will show, artifacts can travel great distances from their procurement and production zones when they address critical resource deficiencies experienced in outlying areas. Rathje's "core-buffer model" (Rathje 1972) was predicated on such realized imbalances between the resource-scarce, densely populated central Petén, and resource-rich, sparsely populated peripheral areas. Several serious erroneous assumptions and mechanical deficiencies undermined the utility of Rathje's

model, but its basic tenet of critical resource imbalances driving interregional trade has recently gained new life in studies of political economy (Masson 2002).

Specialized Production

Studies of Maya political economy have made great strides over the past few decades as archaeologists have discovered unequivocal evidence for regional economic specialization and product distribution. Sites have yielded clear evidence for the specialized production of utilitarian resources such as salt (Andrews 1980; Andrews and Mock 2002; McKillop 1995; Valdez and Mock 1991), stone tools (Dockall and Shafer 1993; Hester and Shafer 1994; McAnany 1989b; Mitchum 1991; Shafer and Hester 1991), ceramics (Foias and Bishop 1997; Rands and Bishop 1980; Rice 1980, 1987; West 2002), and obsidian products (Braswell 2002; Clark 1984; Dreiss and Brown 1989; Fowler 1991; Sidrys 1977). Scholars have also posited the commercial-oriented harvesting of agricultural produce (Guderjan et al. 2003; Harrison and Turner 1978) and marine resources (Graham and Pendergast 1989; MacKinnon 1989), each of which find support among ethnohistoric sources (Blom 1932; Tozzer 1941).

Blom discussed the location of a large chert deposit outcropping near Lake Yaxha in Guatemala and running north approximately to the Mexico border (1932:543). Noting the prevalence of tool forms collected in this area, Blom further postulates that “the arms- and tool-industry of the Maya must have relied heavily on this deposit” (1932:543). The chert source of which Blom writes has not been discussed elsewhere, and it is unclear whether Blom provides this information as a personal account or from a secondary source. Chert outcrops are scattered throughout the Maya lowlands, but the quality and quantity of material they contain varies significantly. Thus far, the only chert outcrop in the lowlands known to have supplied a network of dependent consumer sites is located in what has been called the northern Belize chert-bearing zone (see Figure 2; Cackler, et al. 1999; Hester and Shafer 1984), with production centered at the site of Colha (Hester and Shafer 1994; Shafer and Hester 1991).

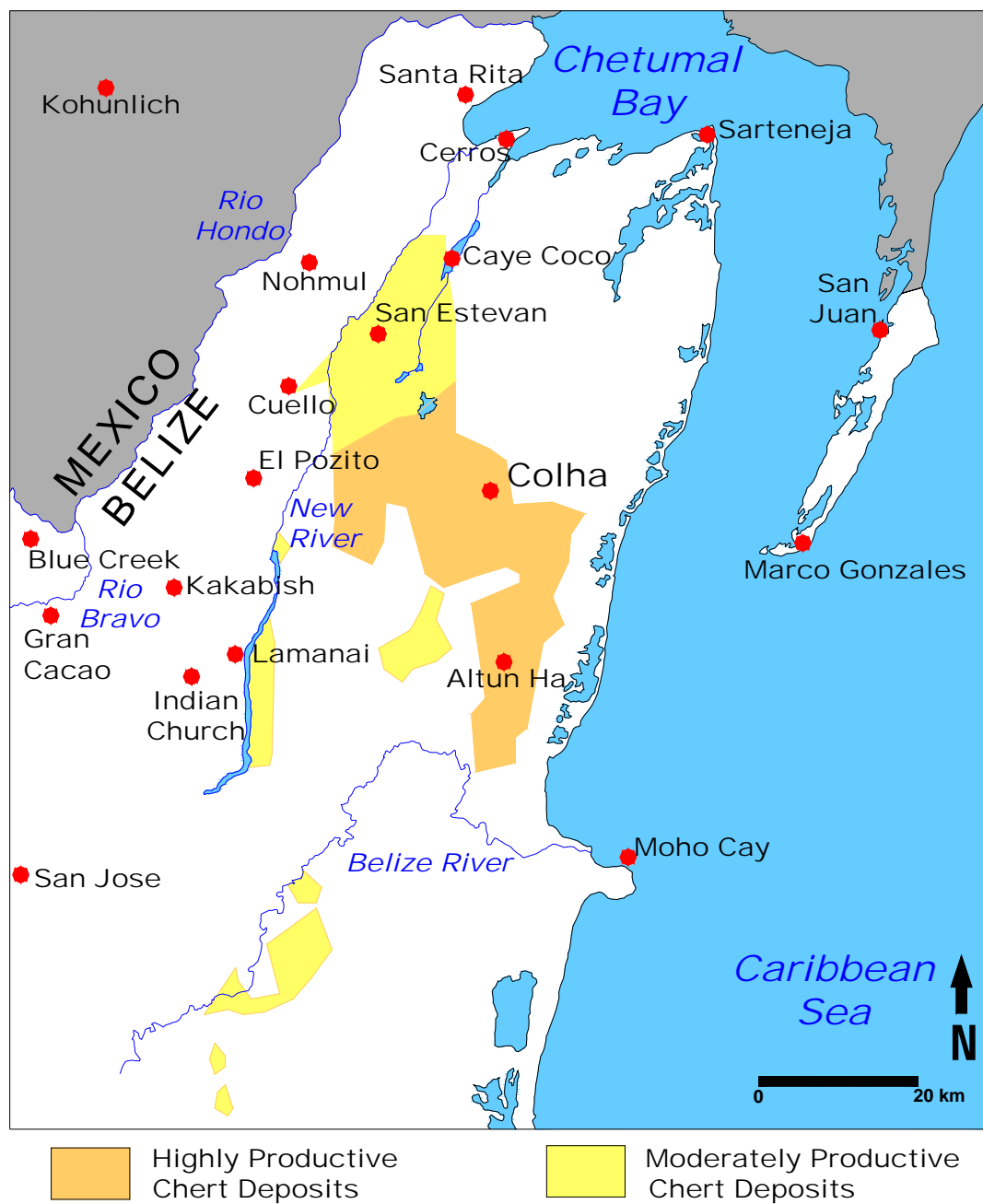


Figure 2: Northern Belize chert-bearing zone.

It is interesting that sites specializing in the production of valuable, even critical commodities seldom appear to have benefited economically from this activity. Sites along the coast of the Yucatan Peninsula and Belize specializing in the production of salt are invariably on the lower end of any ordinal measure of complexity, and show no obvious sign of affluence stemming from their specific economic function. Brasswell (2002) has also noted incongruities between commodity production and economic rewards with regards to the obsidian industry at San Martín Jilotepeque, Guatemala. Similarly, the important stone tool manufacturing site of Colha lacks displays of wealth and opulence exceeding the range of variability expected for sites of its moderate size. Yet the products of Colha workshops were widely distributed to consumer localities from the Late Preclassic through Middle Postclassic periods. This offers enticing, if unsubstantiated, evidence for the administration of resources on a regional scale by geopolitical entities whose control over resources and influence over the labor efforts of dispersed populations extended beyond the boundaries of individual sites as they are currently defined. Sites such as Altun Ha may have reaped the economic rewards of coastal salt production or inland lithic manufacturing through exerting administrative control over these peripheral resource nodes. The important questions to ask then is how such administrative control came to exist, through what social processes and institutions was it internally maintained, and through what mechanisms was it externally protected.

Commodities with primarily social value were also manufactured and exchanged across the lowlands. Among other trade items, jadeite, *Spondylus* shell, hematite, exotic feathers, stingray spines, and cacao were perceived as prestige goods, and served as status markers and ritual paraphernalia (see Tozzer 1941). Their position as such was reinforced by their limited availability, ideological association, and, in some instances, the craftsmanship of their manufacture. Archaeologists have suggested that sites endowed with a greater local availability of these resources were likewise able to exploit them for economic and political gain (Chase and Chase 1988). The commercial value of luxury resources as a form of currency has also been discussed (Freidel 1988; Freidel, et al. 2002).

Equivalencies

All exchange beyond generalized reciprocity (sharing) entails some valuation of goods and services involved in the transaction. Important here is the concept of *equivalencies* as first developed by Polanyi (1944) and elaborated by Halperin (1994). According to Halperin (1994:86), equivalencies “indicate how much of what to transact and in what form, in what order, and in what rhythms, [they] operate in all economies and for all facets of production, distribution, and consumption.” Halperin further states that in “most cultural contexts, equivalencies are fraught with complicated social and political overtones. Even at the band level, equivalencies are complicated indicators of status: kinship, gender, and age” (1994:90). An equivalency then roughly approximates the concept of *price*, but recognizes a standardized value for goods in economies that do not employ a universal monetary unit. The term “money” describes a monetary unit with an agreed-upon unit of value with a worth that is essentially symbolic rather than intrinsic (Schusky and Culbert 1987:126). This symbolic aspect has made designing a cross-culturally valid, unequivocal definition problematic. Schusky and Culbert state that “true money is not found where personal relations are part of the exchange” (1987:126). In other words, the value of a monetary unit is not measured through the social benefits of its use, nor does its value rest in the physical properties of the medium. Rather, its value is supported by a commonly held perception of worth based on innate desirability backed by the institution of the state.

In pre-capitalist markets, such as those described for the Maya above, it is not uncommon for transactions to involve some form of barter (cf. Berdan 1989; Orlove 1986). Barter involves the exchange of goods without the use of money, and can include the negotiation of an exchange rate (Plattner 1989a, 1989b). Market exchange in pre-capitalist societies may be based on the exchange of commodities, the use of a monetary unit, or a combination of these media (Berdan 1989; Orlove 1986). Ethnohistoric sources from the early Colonial period suggest that the value of commodities at Maya markets were regulated in some fashion, yet value was allowed to fluctuate according to the forces of supply and demand. Tozzer (1941:231, from Gaspar Antonio Chi:

Relación 1582) writes: “With provisions there was no bargaining, because the prices (were always) ... in the same way, except for maize which sometimes (rose in price when the crops failed...).” Other ethnohistoric accounts suggests that judges, who were likely to have been local elites, presided over Maya markets to approve ‘prices’ and dissuade exploitation (Ximenez, *Historia de Guatemala* 1929:94 in Blom 1832:545).

The cacao bean is generally regarded as having been used as a currency by the Maya (cf. Blom 1932; Freidel, et al. 2002; Masson and Freidel 2002; Millon 1955). On the use of cacao beans as a form of currency, the early Spanish chronicler Oviedo (1851:316-317 quoted in Tozzer 1941:95) states that “there is nothing among these people, where this money circulates which cannot be bought or sold in the same way in which good doubloons or ducats of two, circulate among Christians.” Oviedo also states that commoners never consumed cacao drinks as this was viewed as the destruction of valuable capital, while nobles freely consumed such drinks and accumulated cacao as a medium for tribute payments. Ethnohistoric sources also suggests that the realized value of cacao beans fluctuated by geographic distance from source areas, adhering to the familiar market principle of supply and demand (Blom 1932:538). Further discussing the exchange and consumption of commodities, Landa writes that:

the occupation to which ... [the Maya] are most inclined is trading, carrying salt, clothing and slaves to the lands of Ulua and Tobasco, exchanging it for cacao and beads of stone which both were like money and with this money they could buy slaves and other beads, granting that they were fine and good, which the chiefs wore as jewelry during the feasts, and they had other beads made out of certain red shells which were valued as money and personal jewelry (*Relacion de las cosas de Yucatan*, 1864:128-30. Genet, 1928 edition)

The stone beads Landa speaks of may have been jade in most instances (Tozzer 1941:95 n.418), and the red shell beads are certainly of *Spondylus* shell. As an alternative commercial unit, Blom writes that “pieces of woven cotton of a stipulated size were monetary units of trade... [and] quetzal tail feathers and jade were used as money”, though he limits economically important commodities such as obsidian, chert (“flint”), and pyrite to being “trade objects” (1932:541-3). The basis for Blom’s distinction between “monetary units” and “trade items” is not made clear. Cacao beans

and stone tools each appear to have been fungible commodities, which is to say that they benefited from broadly recognized value and were therefore useful as currencies in brokering exchange (Adams 1976). Based on the definition of money provided above, however, defining any of the previously mentioned currencies as money is wholly inappropriate. The nature of “currency”, in terms of its availability and fungibility, among the Maya becomes relevant when the economic basis for elite power and ability is considered.

Finance Systems

Maya states were supported by diverse economic structures that were influenced by the local availability of strategic resources. In all cases, a finance system was needed to support the operational requirements of the state and the legitimized demands of its leaders. In order to understand the organizational basis for social inequality, we must first understand the structure of state finance systems and underlying behavioral norms on which they were predicated. The contributions various researchers have made on this topic with regard to the ancient Maya can be synthesized using the archaeological models of political economy provided by Hirth (1996) as a base of departure.

State finance systems are principally concerned with the accumulation of resource surpluses used to support communal subsistence production and storage, the development and maintenance of production and distribution infrastructure, as well as the various administrative and operational costs incurred through such endeavors. Finance systems are the principle component of political economies (Hirth 1996:221). According to Hirth (1996: 209), archaeological models of political economy are typically predicated on production-oriented, service-oriented, or distribution-oriented resource mobilization strategies. Archaeological models of ancient Maya resource mobilization strategies tend to be more often production or distribution focused, thus the following discussion is restricted to examining these models.

Production-oriented Finance Systems

Archaeologists studying the ancient Maya have offered numerous production-oriented resource mobilization models as a means for state finance and elite support. These models most often explain social changes and the emergence of wealth and status hierarchies strictly through internal developments. Influenced by Wittfogel's (1972) hydraulic management model, Scarborough (1993, 1996) has proposed that Maya elites commanded the labor and produce of non-elites by maintaining control over the mechanics of irrigation, and thus the technology of production (Denevan 1982). Hydraulic management became a popular avenue of research at a time when ecologically-based models dominated lowland archaeology. However, the efficacy of such models relies on elites maintaining proprietary access to technical knowledge that may not have been beyond the comprehension of most common farmers. What did lie beyond the grasp of the majority was the ability to command a labor pool large enough to construct the monumental public works projects that enabled intensified production. Furthermore, current evidence suggests that social hierarchies emerged well before complex irrigation systems (cf. Wilk and Wilhite 1991). Hydraulic management models are likely to explain very little of the stratification that existed among the ancient Maya. Complex irrigation projects are more likely to exacerbate already existing inequalities insofar as they encourage greater dependence on the provisioning infrastructure of the state and dissuade emigration. Mann (1986: 42) states: "Fixed settlement traps people into living with each other, cooperating, and devising more complex forms of social organization."

Hirth (1996:211) writes that assigned production mobilizes labor rather than commodities, and thus does not compete with domestic production except with regard for labor investment. With assigned production, non-elites must contribute their labor to elite endeavors. While this may include the construction of elite ceremonial or residential structures or public works, it also includes the production of surplus commodities which elites may in turn use to finance their ambitions. There is a good deal of support for the assigned production model. First, several ethnohistoric sources

support the institution of assigned production at the time of European contact (Hicks 1984; Roys 1957). Landa, for example, states that commoners built the houses of their lords (in Tozzer 1941:86), though he does not stipulate whether this was out of obligation or reverence. Indeed, such a distinction may be convoluted. Assigned production finds additional, if inferential, support from the magnitude of labor invested into elite architecture, defensive walls and moats, causeways, reservoirs, and other earthworks. One possible problem for the assigned production model is in its exclusive reliance on tributary labor. Several depictions of ancient Maya courts rendered on polychrome ceramics and monuments clearly show rulers receiving tribute bundles (Coe and Kerr 1998; Reents-Budet 2001), indicating that their entitlements extended beyond claims to labor. One caveat: tribute bundles depicted in Maya art most often appear to emanate from outside polities, and may represent tribute payments between vassal elite and their royal patrons (Schele and Mathews 1998); they may not imply that tribute in the form of commodities was commanded by nobles from commoners.

Claims to labor and claims to production are equally viable finance systems, but with distinct connotations for the nature of elite power and degree of inequality within a society. With assigned production, rulers have no claims over the domestic production of those they rule, leaving hinterlands fairly autonomous with regard to economic pursuits. Assigned production models are in accord with the inherently weak political authority found in Southeast Asian theatre states and galactic polities (Demarest 1992, 2000; Geertz 1980).

Controlled craft production is another resource mobilization strategy that has achieved some popularity among Maya scholars (Becker 1983). The premise of controlled craft production models is that craftspeople are attached to and dependent on elite households, or else they are the elite themselves (Ball 1993; Clark and Parry 1990; Hirth 1996:213; Reents-Budet et al. 1994). In another version of the model, a craftsperson may be required to obtain raw materials through elites or else give a portion of what they produce to elites (Clark and Parry 1990; Hirth 1996:214). As a finance system, controlled craft production via “attached specialists” may also be viewed as one

derivative of already extant inequality (Earle 1989:67; McAnany 1989a:359). In order for controlled specialization to function as a finance system, that which is controlled must be of general value (preferably a critical resource), and the materials or technology of production must be alienable. Alienating knowledge of scribal arts, such as painting polychrome ceramics or inscribing hieroglyphic monuments, would have provided prestige but few economic rewards to Maya elite as commoners were seldom patrons of these products (cf. LeCount 1999:251). As McAnany (1989a:359) characterizes this process as follows:

these specialists produce high-value wealth goods, often from rare materials, which can be used by elites for a number of purposes, including status affirmation, alliance building, reward for loyalty and feats of courage and, sometimes, a rudimentary form of currency. These specialists are supported by taxation of the general populace – who, ironically enough, are generally denied these goods by draconian sumptuary laws.

Monopolizing the production of a critical utilitarian commodity such as stone tools would have provided much greater rewards if either knowledge of production technology and access to viable raw materials could indeed be alienated from commoners. As the Maya relied on stone tools for their livelihood, it is likely that production technology was widely known, taught from one generation to the next, and quite inalienable. If controlled craft production did serve as a system of state finance, it seems more likely that it was based on governing production of staple utilitarian crafts, and that control was predicated on raw material access restrictions. The benefits bestowed upon elites in exchange for granting critical raw material use-rights would logically make governing the actual production of utilitarian crafts superfluous.

Distribution/Exchange-oriented Finance Systems

Several distribution- or exchange-oriented state finance models have been proposed to describe ancient Maya political economy. These range from elite distribution models (Clark and Blake 1994; LeCount 1999), interregional exchange (Andrews 1990; Aoyama 1999; Brumfiel and Earle 1987a; Dunham 1996; Freidel, et al. 2002; Garber 1985; Guderjan 2002; Hirth 1984; Hirth 1992; McAnany 1989b; Rands

and Bishop 1980; Rathje 1972; Sabloff 1977; Sabloff and Rathje 1975; Tourtellot and Sabloff 1972; West 2002), world systems linkages (Blanton and Feinman 1984; Kepecs, et al. 1994; Peregrine, et al. 1996; Schortman and Urban 1996), staple finance and/or tribute mobilization models (Freidel 1981; Thompson 1954), and strategic resource control (Andrews 1980; Ford 1996; Lucero 1999; McAnany 1995; Scarborough 1998).

Several authors have argued that interregional commercial integration initiated through the exchange of prestige goods between distant elites, with exchange of utilitarian goods developing as an ancillary effect (Berdan 1980; Blanton and Feinman 1984; Brumfiel 1980, 1983; Flannery 1968). This conforms to a politically-oriented model of developmental political economy, in contrast to adaptation-oriented models whereby utilitarian goods are exchanged between regions in response to local resource deficiencies and managerial policies (cf. Brumfiel and Earle 1987b). The primacy of elite exchange over utilitarian exchange needs to be more thoroughly tested. At Blue Creek, evidence for regional exchange in utilitarian commodities dates as early as the Middle Preclassic period, whereas non-local prestige items do not occur in the archaeological record until the Late Preclassic (this is more thoroughly discussed in Chapter VI). Utilitarian exchange is as likely to have been based on consumer preference as it is actual need. Masson (2002:15) states that “Complex economic systems create consumer demands that transcend issues of local self-sufficiency, often to a considerable extent.” Trade networks constituted a salient provisioning source for commodities that were unavailable locally, as well as goods that competed with or presented desirable alternatives to local goods. In the context of the present study, the most relevant consideration with respect to the character and natural distribution of lowland resources, and with regard to interregional trade in these assets, is how each of these influenced the structure and scope of tactical opportunities locally. Restated, the local abundance or scarcity of specific resources, together with the efficiency of commodity distribution networks, placed limits on, enabled, and provided motivation for the growth of local political economies.

World-systems Linkages

World-systems linkages are not likely to have been a primary method of state finance among the ancient Maya, especially if world-systems theory is regarded separately from simple inter-regional trade and peer-polity interaction (McGuire 1996; Renfrew 1986; Renfrew and Cherry 1986). First, the production scheduling, craft specialization and mobilization of resources in logistical support of multi-regional economic integration, an inherent factor in world-systems linkages (Wallerstein 1974, 1980, 1989), is not likely to have occurred in the absence of already established political hierarchies (McGuire 1996). Regional and long-distance trade may have linked sites economically and provided the incentive for political cooperation, but such political and economic linkages were undoubtedly fragile and based primarily on the realization of self-interest. Secondly, world-systems linkages imply a sort of macro-regional caging with a well-established dominant core and equally well-established exploited periphery (McGuire 1996; Wallerstein 1974). As such, world-systems models are far more applicable to the highland states of Central Mexico than they are to lowland Maya states. For Maya states to have received fiscal support through world-systems linkages, as Wallerstein (1974, 1980, 1989) has applied world-systems theory to the capitalist world economy, political elites would have had to influence economic practices among dispersed hinterland producers to the point that domestic self-sufficiency was undermined. Household and corporate labor, particularly at peripheral sites, would be geared toward producing economically advantageous export commodities, culminating in the partial reliance on subsistence imports. At the same time, the co-dependence cultivated among networked sites, due to their mutual dependence on import commodities, would exceed the scope of political influence expressed by member states (Hirth 1996:219; Earle 1977). This broad-scale, macro-regional economic integration and manufactured interdependence, implicit within world systems theory, is not supported archaeologically in the Maya lowlands.

A resource-mobilization system, as detailed by Hirth (1996:220), refers to “the collection of raw materials and finished products without a direct and measurable

counterflow of goods and/or services to the contributing group.” Marcus (1993:131) has noted that a distinction can be drawn between *tribute*, referring to goods elites receive from external sources, and *taxation*, referring to goods received by elites from internal sources. Using this distinction, tribute may be linked to military conquest (Marcus 1993:130; Webster 1993:432), or scheduled resource flows between dominant and vassal centers within a hierarchically organized regional interaction network (Hammond 1990; Marcus 1976, 1973). In contrast, taxation is an economic burden that political elites levy on a populace, claiming a portion of the resources they produce. Taxation systems entailing the transference of products or material resources from domestic producers to elites is an effective means of state finance on which the development and maintenance of social inequality may be predicated. Resources mobilized in this fashion support the subsistence needs of elites and allow them to “fund new institutions and activities calculated to extend their power.” (Brumfiel and Earle 1987b:3; Earle 1978). Ethnohistoric sources document tributary flows among the Maya between hinterland non-elites and regional paramounts at the time of European contact (Roys 1957; Tozzer 1941:63, 87, 97), and it appears likely that such transactions occurred further back in Maya prehistory. In fact, several theories relating to the Maya collapse have focused on tributary (or tax) burdens as the direct or indirect cause of the socio-political dissolution observed from the late eighth through early tenth centuries in the Maya lowlands (Adams 1973; Kidder 1950; Thompson 1966). It seems certain that resource mobilization was a basic component state finance systems among the ancient Maya. How this mobilization was legitimized is another matter.

Arguments for strategic resource control among the Maya were reviewed earlier in this chapter and will not be reexamined here. The central claim of such arguments is that the ability of rulers to alienate members of society from directly accessing critical resources, whether through coercive force or the tactical manipulation of use-rights, significantly effects the distribution of economic capabilities. Other forms of elite control and non-elite marginalization may well originate from a fundamental imbalance in the distribution of basic endowments (Brumfiel and Earle 1987b:3). Resource and

labor mobilization may, for example, be legitimized as compensation for the allocation of use-rights.

Maya Politics and Economy in Perspective

The political and economic integration of Maya society may be approached from an internal, polity-centered perspective or an external, regionally-oriented perspective. From an internal perspective, formal organization can be viewed as a negotiation between the centrifugal forces of kinship and desired autonomy (Fox and Cook 1996; Fox, et al. 1996), and the centripetal forces of ceremony (Brady and Ashmore 1999; Demarest 2000; Freidel 1992; Freidel and Schele 1988; Scarborough 1998; Schele, 2000), security (Webster 2000), and economic interdependence (VandenBosch 1999). From an external perspective, formal organization can be viewed as resulting from foreign-derived coercive force or imperialism (Barrett and Scherer 2002; Demarest et al. 1997; Martin and Grube 2000; Webster 1993, 1998), or economic resource dependencies which established producer-consumer relationships (Andrews 1980; Dockall and Shafer 1993; Hester and Shafer 1994; McAnany 1989b; Shafer and Hester 1991). Each perspective offers a pathway to social integration, the structural stratification of communities, and ensuing inequality. However, the motives for inception, mechanisms of continuance, and means of legitimizing inequalities are contrastive between them.

Halperin (1994:91) suggests that in pre-capitalist states, “households will be linked to the state through some form of redistributive system ... that links the state center and the communities and households at the periphery”, and that “households at the periphery can be insulated to some degree from state demands by local and regional officials.” This addresses two fundamental points of contention in lowland Maya archaeology; what role did local elites assume in the procurement and redistribution of commodities consumed at the household level, and how well integrated were Maya polities. There is considerable conceptual ambiguity in modeling the “linkage” extant between the various segments of Maya polities (Fox, et al. 1996:795). This ambiguity stems from the uncertainty of scholars as to the nature and basis of coercive power

enjoyed by potentates, and the degree of autonomy hinterland populations realized with regard to their uninhibited participation in state economies. It is quite likely that the nuances of lowland Maya states were significantly divergent, particularly with regard to the actual power enjoyed by local elites and the autonomy of hinterland populations. The entitlements and obligations of Tikal's potentate may have been quite different from the principals of Calakmul, Caracol, Chichen Itza, or any other regionally powerful geopolitical entity.

Maya economies were administered economies, meaning that their complex structure and enduring viability demanded a level of social integration beyond the level of individual households and corporate groups, often at an extra-polity scale. One of the great enduring mysteries of the Maya is how they managed to accomplish such local and regional integration while maintaining a dispersed settlement structure. Ceremonial obligation and ideological diffusion have been offered as possible mechanisms for fostering such solidarity (Demarest 1992; Freidel 1981; Rathje 1972), though these methods do not provide for the sort of social control suggested by the durability of long-distance producer-consumer relationships throughout the lowlands. In particular, Demarest (1992, 2000) has suggested that the fragile political architecture that existed within and between Balinese *negara* (Geertz 1980: 4) accurately characterizes the structure of lowland Maya states. Describing the Balinese theatre state, Geertz (1980:13) states the following:

The expressive nature of the Balinese state ... was always pointed not toward tyranny, whose systematic concentration of power it was incompetent to effect, and not even very methodically toward government, which it pursued indifferently and hesitantly, but rather toward spectacle, toward ceremony, toward public dramatization of the ruling obsessions of Balinese culture: social inequality and status pride.

Demarest (1992, 1996) has written that Maya political structures were inherently weak and based on shared ideology and ceremonialism, accounting for their tendency to fission, similar to those in Southeast Asia (after (Geertz 1980)). The Maya "galactic polity", according to Demarest (1996:823; after Tambiah 1977), was a fragile, hegemonic alliance of polities, each containing a more or less redundant set of political

structures. Leaders relied predominantly on the artifice of ideology and ritual as the source of their power and legitimacy and realized little actual control over economic infrastructure (Demarest 1992, 1996, 2000). In this model, the lack of broad coercive authority on the part of Maya kings, combined with the absence of organic solidarity and the centrifugal force of self-interest, caused larger geopolitical amalgamations to be intrinsically unstable. The galactic polity model, as applied to the Maya, may underestimate the economic interdependence of polities, and almost certainly places too much emphasis on a patchwork epigraphic record in tracing the lifecycle of macro-political entities. Also, regional hegemonies in the Maya lowlands lasted far longer than those they have been compared to in Southeast Asia (Martin and Grube 2000), suggesting that the integration of Maya society, on a regional level, was based more on the development of what Mann (1986: 42, 75) has labeled social “caging.”

The “caging” of lowland populations and manifestation of formal, coercive political authority is likely to have taken place on multiple occasions and propagated along multiple pathways, each time as the result of a particular set of historic circumstances (Cioffi-Revilla and Landman 1999). This would account for the mounting evidence for multiple “collapse” events (Webster 2002), and for the ultimate failure of the lowland Maya to coalesce into a single, homogenous political entity (Demarest 1996:822). Regardless of what triggered state development in any one circumstance, the conditions for complex social organization and overarching, coercive political institutions became entrenched once lowland populations acquiesced to a fully sedentary, agricultural lifeway (cf. Mann 1986:42).

CHAPTER III

THE SITE OF BLUE CREEK, BELIZE

Introduction: Objectives of Section

This chapter introduces the ancient Maya site of Blue Creek, located in northwestern Belize. The Blue Creek settlement zone is situated along the eastern edge of the Rio Bravo escarpment, which runs approximately north-south and demarcates the eastern boundary of the Petén Plateau (Figure 3). Ancient Maya settlement associated with the Blue Creek polity is found on the Rio Bravo floodplain at the base of the escarpment, as well as atop the escarpment, rising 80-160 meters above the floodplain (Figure 4). While it is clear that portions of the ancient Blue Creek community extended up to the banks of the Rio Azul, it is not clear whether portions of the community extended north of the river into Mexico due to survey and permit restrictions. It is currently believed that there was no substantial settlement north of the river (Guderjan et al. 2003).

The political and economic relations between individuals and groups within the ancient Maya community at Blue Creek, and those between Blue Creek and other polities within this region, are the principal topics of this work. To better understand local and regional economic patterns, I first discuss the site of Blue Creek in terms of its geo-ecological setting. As I show, the geological history of the area is a vital consideration in terms of its impact on the presence and distribution of economic resources, and subsequent influence on patterns of human settlement and resource exploitation. I next discuss archaeological research at the site from a historical and material systems perspective. Investigations at Blue Creek have evolved in scope and complexity since the project's inception, and many current avenues of research are addressing critical and poorly understood aspects of Maya prehistory. This work offers a unique examination of critical resource control and its role in the development and maintenance of social stratification.

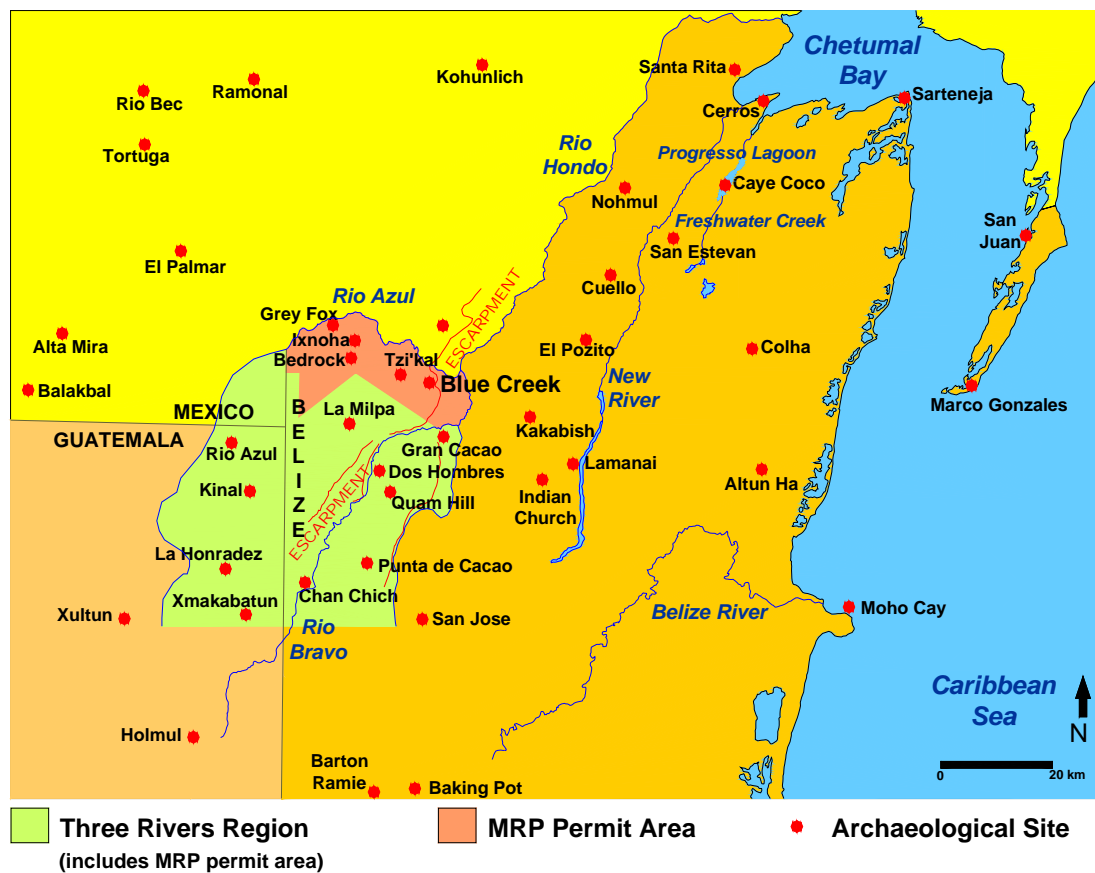


Figure 3: Location of Blue Creek in relation to Rio Bravo escarpment and Three Rivers Region.

Following a discussion of archaeological research at the site, I discuss cultural characteristics of the Blue Creek community from a temporal perspective. The complexity of the community is discussed in terms of relative size, structural differentiation, social stratification, and economic specialization. Finally, I evaluate the varying degree of political and economic self-sufficiency and dependence exhibited by the Blue Creek community using broader regional and extra-regional perspectives. In terms of spatial and temporal facets of its natural and cultural environs, the context of the Blue Creek community that I develop in this chapter serves as the basis for understanding the dynamic variability in lithic resource exploitation patterns that I illustrate in later chapters.

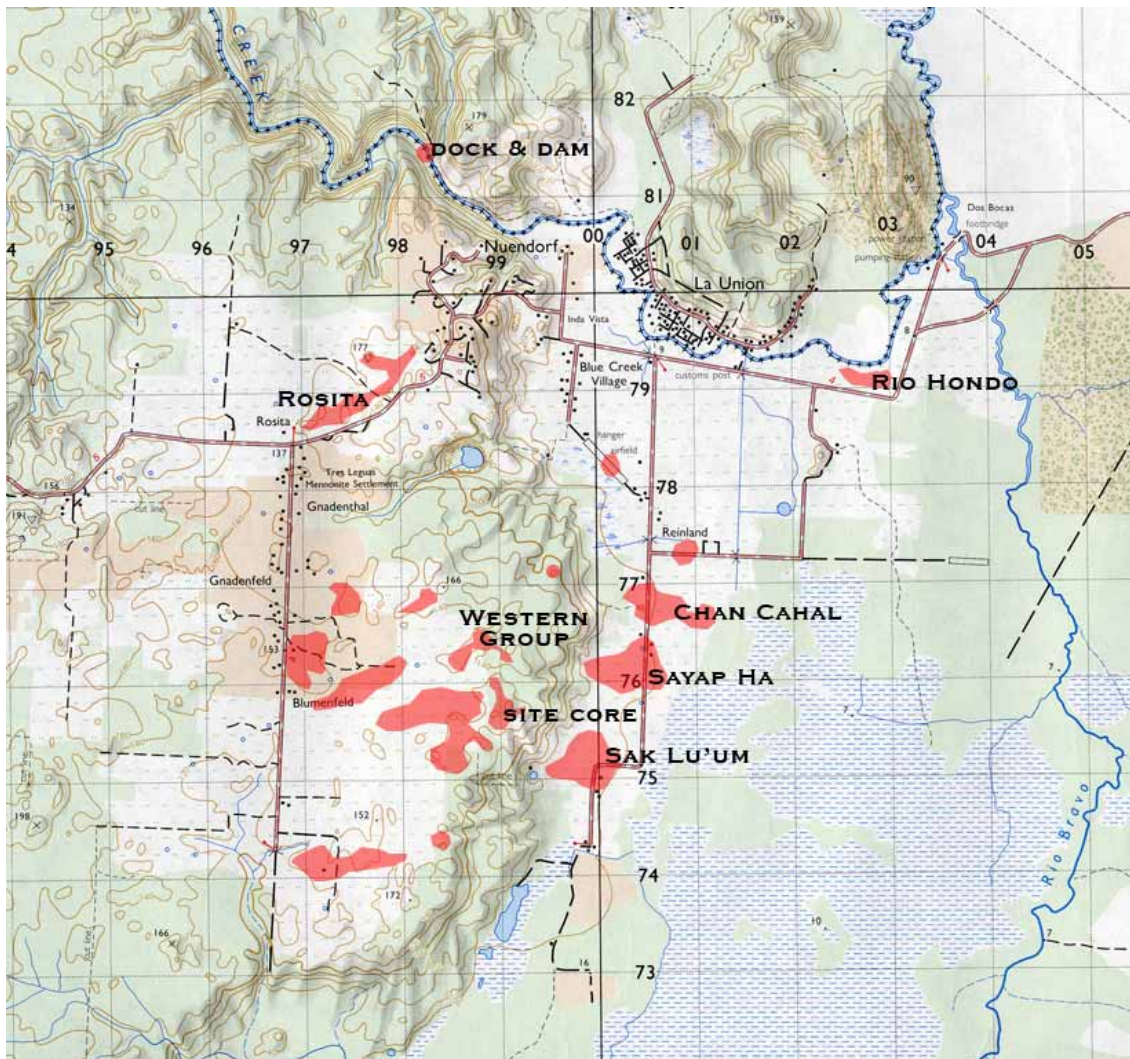


Figure 4: Distribution of known settlements within the Blue Creek polity.

Geological History

Karst Landscape of the Yucatan Platform and Petén Plateau

Blue Creek is located in northwestern Belize at the eastern margin of the Petén Limestone Karst Plateau, a part of the physiographic feature known as the Yucatan Platform (Figure 5). The Yucatan Platform underlies the modern states of Yucatan, Quintana Roo, and Campeche in Mexico, the Department of Petén in Guatemala, and the majority of Belize. The geologic origins of the Yucatan Platform are thought to date to

the Precambrian Period when the igneous and metamorphic substrate formed, with major alterations occurring during the Mesozoic Era by way of a series of erosion and deposition events (Wilson 1980). Initial deposition of dolomite and limestone layers occurred during the early Cretaceous period when the sea began to cover the Platform. The limestone and dolomite formations of the upper escarpment, on which the Blue Creek site core is located, were emplaced by the early Tertiary Period. By the end of the Tertiary, the Yucatan Platform had emerged from the sea and coincident with a dramatic drop in sea level, subsequent erosion produced many of the topographic features that presently characterize the region. Lene (1997:14) has described the geologic features of the upper escarpment, stating:

The area west and northwest of the escarpment is a high plateau with fairly irregular, mature karst topography, a surface produced by the dissolution of the underlying carbonate rocks. Evidence for this is seen in the numerous sinkholes, the shallow valleys which generally lack surface drainage features, and the fracturing, solution and collapse seen in exposed bedrock surfaces.

Chert and Chalcedony Formation

The limestone substrate of the Yucatan Plateau provides a productive environment for the formation of chert and chalcedony. Chert and chalcedony were commonly used by the ancient Maya for the construction of flaked stone tools owing to the fracture properties of these minerals. Both materials fracture consistently and predictably, have high compressive and tensile strength, are durable as the result of the mineral's inherent hardness, and produce sharp, resilient edges. Chert is an amorphous silica without an observable crystalline structure that is found in a variety of geological contexts. It outcrops mainly in sedimentary deposits, but may also be found in metamorphic and volcanic deposits, as well as within oceanic sediments (Sieveking and Hart 1983). Chert deposits may manifest as spherical-to-tabular nodules, thick beds, or thin lenses. Its formation is currently thought to be a complex multilinear process

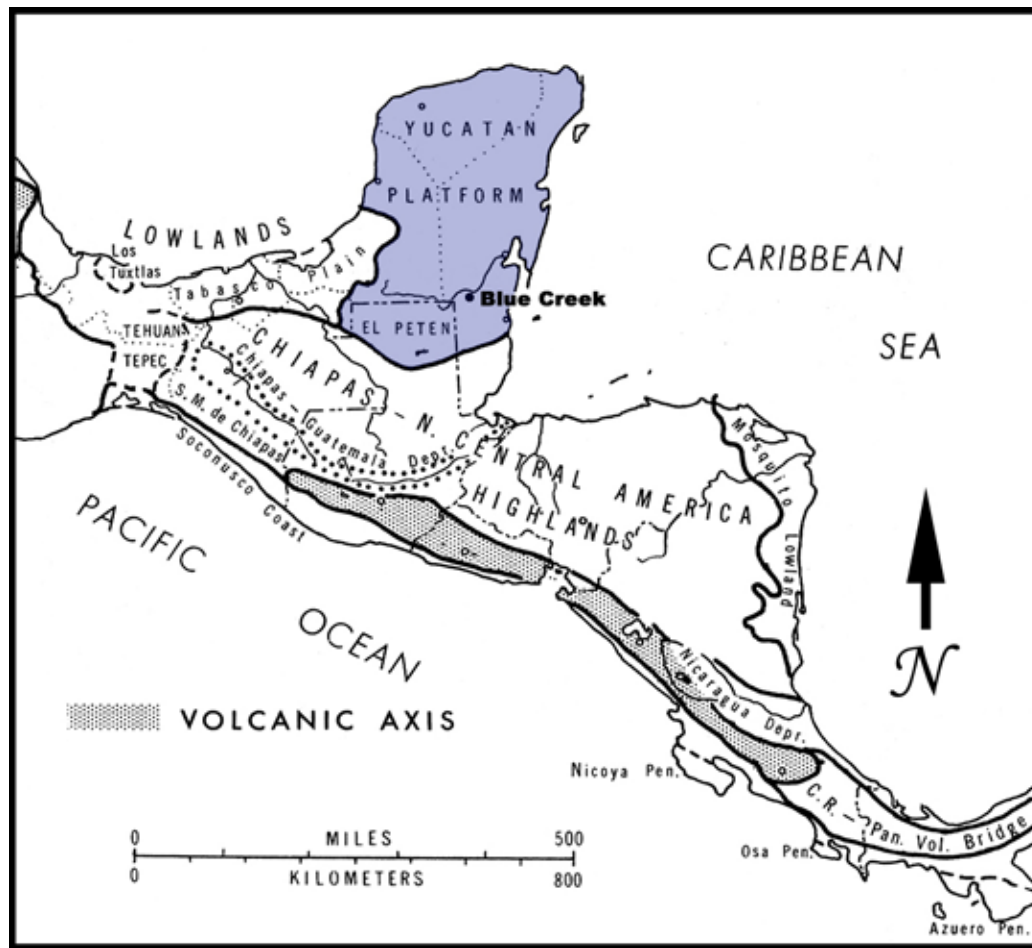


Figure 5: Physiographic regions of southern Mesoamerica showing the extent of the Yucatan Platform and the location of Blue Creek, Belize (adapted from West 1964, Fig. 3).

involving the solution and precipitation of silica (Luedtke 1992). The origins of chalcedony are not as well understood, but the mineral may be found in many of the same environments as chert. Chalcedony is not amorphous silica like chert, but rather is semi-crystalline, with crystals growing in bundles of radiating fibers (Luedtke 1992). It is often translucent, incorporating few of the mineral impurities found in cherts, which ultimately give chert its color and opacity. The characteristics of chert are decidedly variable between outcrops, in part reflecting the variability of the parent material in which it is found. Cherts are highly variable with regard to grain size, micro and macro

fossils, mineral impurities, and outcrop characteristics (such as nodule size and shape, or thickness of lens). Chalcedony does not vary as much in color or grain size as chert, but otherwise exhibits similar variability.

Many chert and chalcedony outcrops throughout the lowlands take the form of nodules eroding from or quarried out of limestone parent material, while others are carried in river systems. Productive deposits are often located adjacent to *bajos* where soils retain high water content, resulting in greater erosion of bedrock limestone. The most productive outcrops in the Maya Research Program (MRP) permit area occur in and around the Dumbbell Bajo (Figure 6), located approximately 12km west of the Blue Creek settlement zone. These outcrops are dominated by chalcedonies and, to a lesser degree, fine-grained cherts. In the Blue Creek settlement zone, productive outcrops occur in the modest *bajo* surrounding the Rosita area north of the site core, and southwest of the site core in deep arroyos. Both deposits predominantly contain coarse-grained chert, with sedimentary quartzites also being found in the Rosita *bajo*. Few productive raw materials are found in the savanna landscape below the escarpment, with the exception of silicified limestone, which is of little utility save for the construction of groundstone tool forms with low durability.

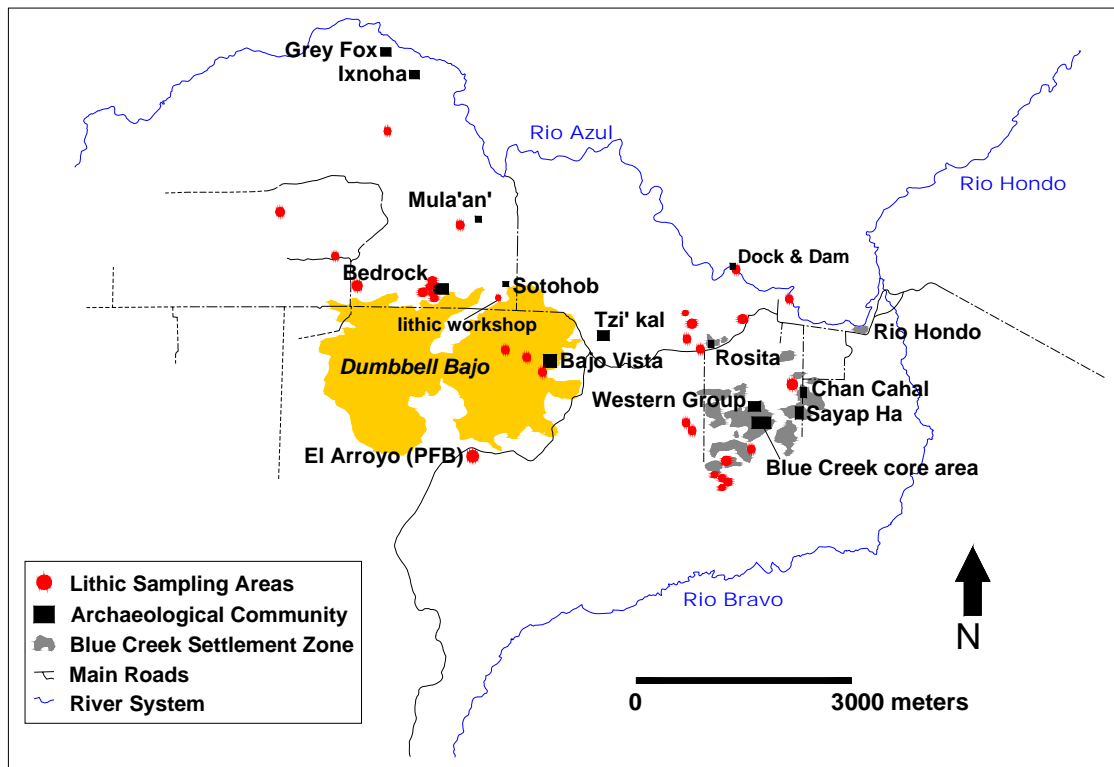


Figure 6: Distribution of raw material sampling areas across the MRP permit area.

Soils

The soils below the escarpment have developed on the floodplain of the Rio Hondo and Rio Bravo. Closer to the banks of these rivers, the soils are rich in nutrients and of moderate depth (Guderjan, Baker, et al. 2003). In several areas, the underlying carbonate bedrock rises to form residual hills. Soils on and around these elevated areas are residual in nature, are primarily composed of eroded parent material, and are often quite shallow with moderate to low fertility (Guderjan, Baker, et al. 2003). The settlement zone below the escarpment is comprised of the Chan Cahal, Sayap Ha, and Sak Lu'um precincts. These settlement precincts are situated within a savanna landscape along a remnant limestone ridge that exemplifies such areas of shallow residual soil formation (Figure 7). Soils have accreted from erosion off the face of the escarpment

between this settlement zone and the base of the scarp. These soils are typically very thick and of moderate-to-high fertility. A remnant network of ancient channelized fields covers this area, attesting to efforts on the part of the Maya to control water levels in this area and exploit these rich, thickened soils for intensive agriculture (Guderjan 1996; Guderjan, Baker, et al. 2003).



Figure 7: Savannah landscape east of the Rio Bravo escarpment (photo courtesy of Jon C. Lohse).

Soil characteristics are highly variable above the escarpment. Due to the karst terrain, soil nutrients are not well retained. The rolling landscape is dominated by shallow, residual soils that are highly susceptible to erosion. In such areas, the ancient Maya occasionally constructed terrace systems and check dams to maximize agricultural potential while controlling soil loss (Turner 1983). It is interesting that each of these

engineered features have been recorded at Blue Creek. Shallow depressions caused by the erosion of underlying limestone bedrock and subsequent collapse of the solution cavity, called *rejolladas*, are also common topographic features of the upper escarpment plateau. These shallow sinks frequently act as sediment and nutrient traps, making *rejollada* soils thick, nutrient rich, and highly productive (Kepecs and Boucher 1996).

The landscape west of the Blue Creek settlement community, near the sites of Bedrock and Ixnoha, exhibits similar topography and soil components, though with the addition of immense *bajos*. The soils of these low, flat depressions are typically clay-rich and may be seasonally inundated. Although they are typically at least of moderate fertility, drainage problems may have limited their utility for intensive agricultural production by the ancient Maya.

Climate

Blue Creek is located between 18°00' and 17°50' at 88°55' west longitude, placing it within the subtropical moist life zone of the Holdridge Life Zone system, where only minor seasonal variation in temperature is observed (Holdridge 1947; Wright et al. 1959; Figure 8). However, climatic patterns may be highly variable from year to year. Daytime temperatures average approximately 24°C (75°F) from November through January, while nighttime temperatures for the same period average approximately 10°C (50°F). The warmest annual temperatures occur April through June, with daytime temperatures averaging 32°C (90°F) (Brokaw and Mallory 1993).

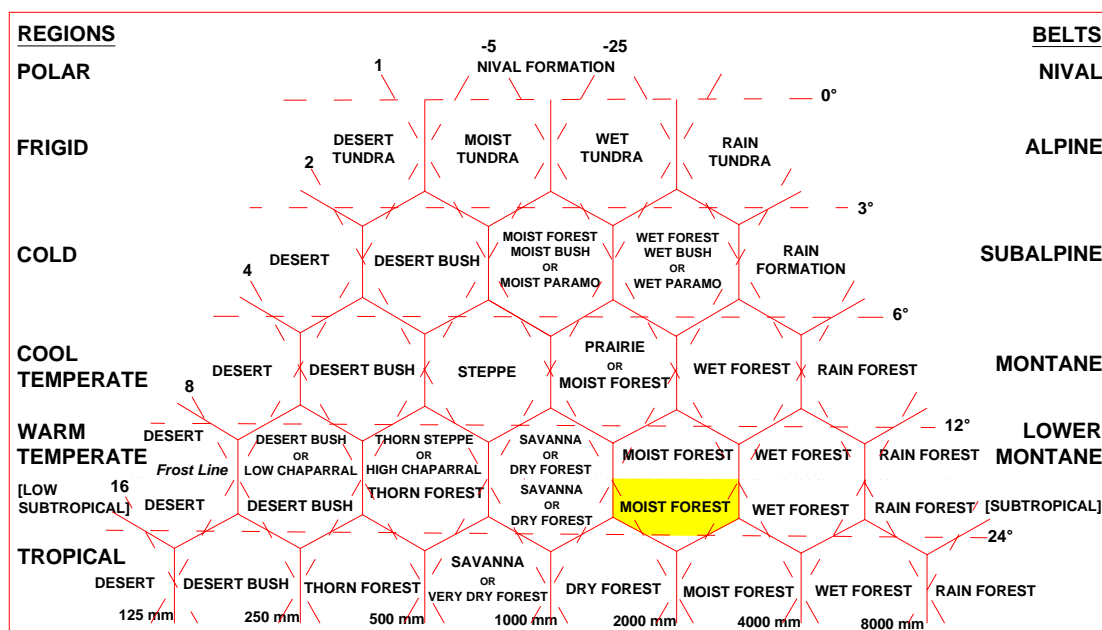


Figure 8: Position of Northwestern Belize in the Holdridge Life Zone System (after Holdridge 1947).

Seasons are marked by changes in rainfall, with the classic tropical pattern of a wet season and a dry season prevailing. The wet season in northwestern Belize lasts from June until January, though rainfall may sharply decrease in November and December (Brokaw and Mallory 1993). The dry season extends from February through May, with peak dryness occurring in April when only about 30mm of rain may be expected. Total average rainfall in northwestern Belize is 1500mm (60 inches) (Brokaw and Mallory 1993; Figure 9). The amount of rainfall per year is highly variable, as is the duration and intensity of the dry season. Tropical storms and hurricanes traveling west from the Atlantic or east across Guatemala from the Pacific may bring high velocity destructive winds and torrential rains, especially from August through October. Fields and *bajos* may become inundated and hill slopes generally experience greatly increased erosion when such storms occur.

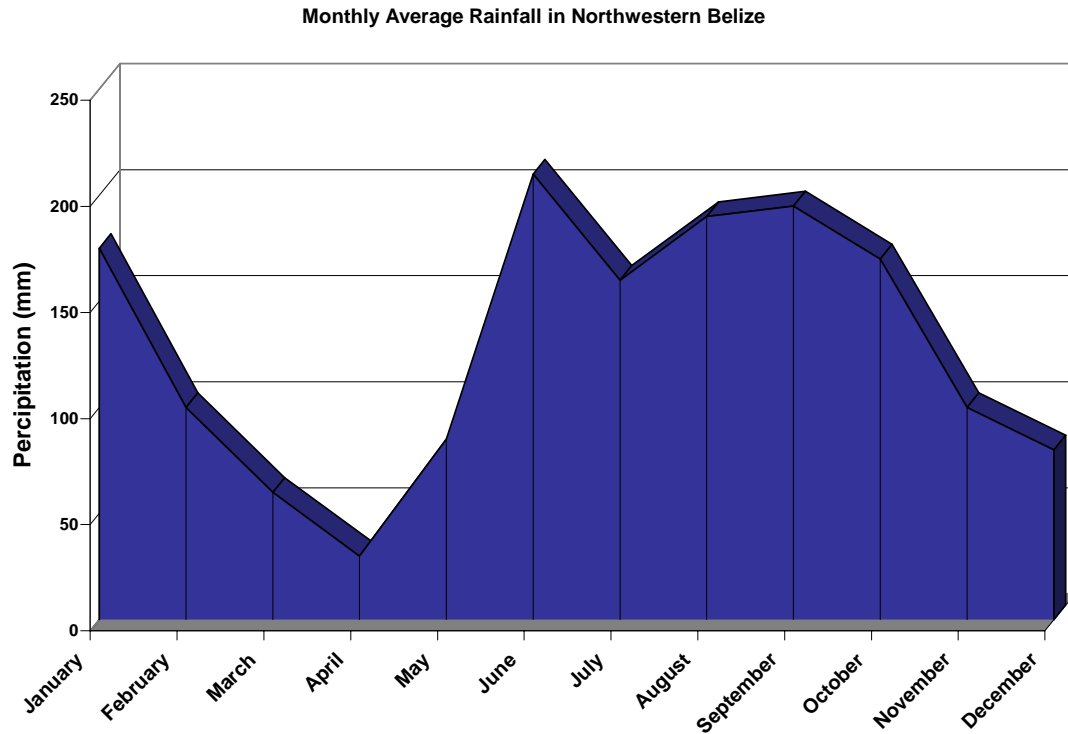


Figure 9: Average rainfall chart for Northwestern Belize (after Brokaw and Mallory 1993).

Hydrology

The karst topography of the Rio Bravo escarpment holds little surface water. Most rainwater drains through the porous substrate until it reaches the water table. Subterranean groundwater flows downslope, emerging at the base of the escarpment and forming shallow lakes, springs, and marshes (Lene 1997). Groundwater may also exit into the deeply cut stream valley of the Rio Azul.

The Rio Azul demarcates the northern boundary of the Maya Research Program's project area, and is the dominant riverine corridor on the landscape. The Rio Bravo marks the eastern border of the project area, and together these rivers merge to form the Rio Hondo, which flows generally northwest, emptying into the Bay of Chetumal. The valley walls of the Rio Azul drop steeply in most areas, and the easiest access to the river is from the base of the escarpment. There are no other permanent

streams in the Blue Creek settlement zone, though several arroyos exist where erosion through intermittent flooding has created drainage channels.

Surface water is available in springs, aguadas and cenotes within the settlement zone. Several small freshwater springs have been identified near the base of the Rio Bravo escarpment near the Chan Cahal and Sayap Ha settlement zones. Aguadas - shallow silted-in basins- occur in dispersed localities above the escarpment. However, several of the aguadas currently present may be recent features associated with modern cattle pastures. Aguadas are not perennial water sources, and rainfall is needed to replenish the resource. Cenotes are collapsed solution cavities which have exposed the water table. Surface water is constantly available in such features, but they are not common features in this region. There are, however, several cenotes close to the Blue Creek ruins (see Figure 4). The first, Crocodile Lake, is located approximately one kilometer southeast of the Rosita community. The second is a dry cenote reported by Mary Neivens approximately one-half kilometer southeast of the site center (Neivens 1991). A third cenote, Blue Lake, is located approximately 3.5 km south of the site core at the base of the escarpment, and is the major element in a chain of small, shallow lakes. Cenotes have also been located immediately west of Plaza B and at the base of the escarpment directly below the site core (Guderjan, personal communication 2004).

Standing water may have also been seasonally available in *bajos* and marshes, although this water may not have been potable. Drainage channels dug into the fields at the base of the escarpment were also a likely source area for surface water. It has also been suggested that channels such as these may have been utilized as fish farms (Thompson 1974; Turner and Harrison 1978). Reservoirs dug by the Maya to retain rain water have also been described (Weiss-Krejci and Sabbas 2002). Although no such feature has been identified in the Blue Creek settlement zone, a possible reservoir is associated with a lithic workshop in the Bedrock community to the west.

Environmental Zones

Given its geographic location and altitude, Northwestern Belize supports subtropical moist vegetation, according to the Holdridge life-zone classificatory system (Holdridge 1947). Vegetation is significantly affected by topography and soil conditions, as well as temperature, elevation, and rainfall. In a survey of the Rio Bravo Management Area conducted by Brokaw and Mallory (1993), the area immediately south of the Maya Research Program's permit area, the authors found that the three dominant vegetation types across the region were upland forest, transitional forest, and scrub swamp forest (Figure 10). Other vegetation patches located within the region included cohune palm forests, riparian forests, palmetto savannas, swamp mangrove, agricultural and pasture fields, large *milpas* (often located in *bajos*), and recovering fallow areas.

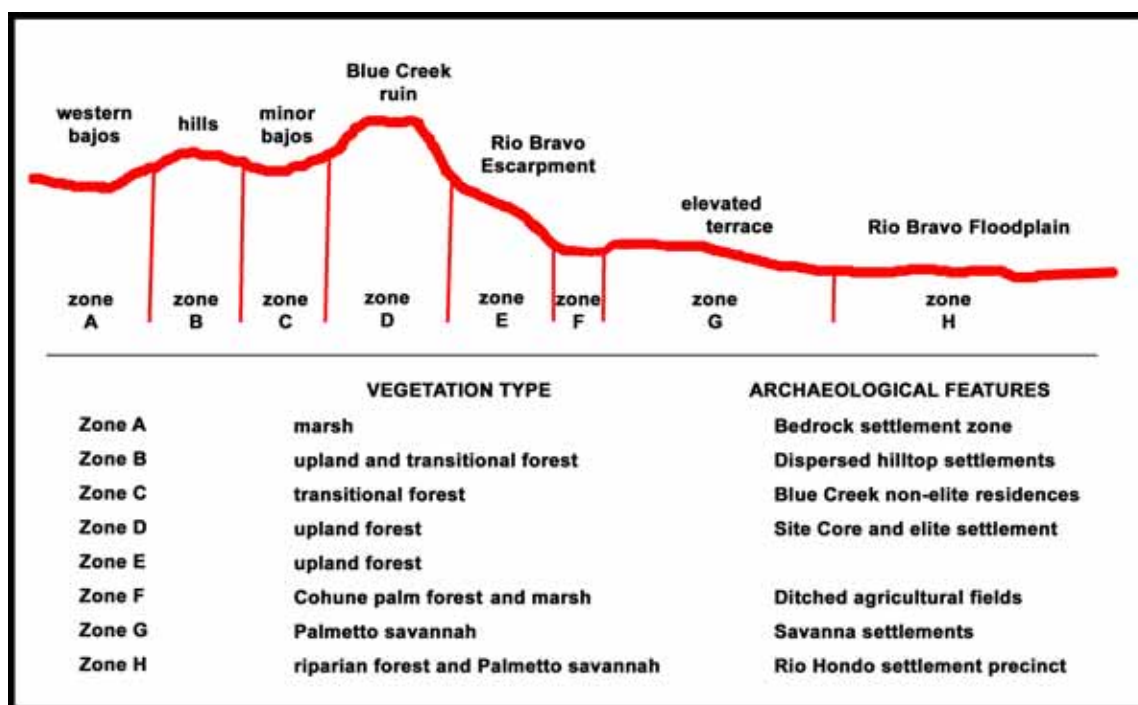


Figure 10: Idealized transect showing the dominant vegetation types and archaeological features associated with Rio Bravo escarpment (after Wright et al. 1959; Brokaw and Mallory 1993).

Upland forests in the project area are generally located on well-drained soils, typically where a gradient is present to encourage surface flow. Upland forests are found on hill slopes of the plateau or on the escarpment face (Brokaw and Mallory 1993). Scrub swamp forests are typically found on the poorly-drained, clay-rich soils characteristic of *bajos* and *rejolladas*. These soils may become saturated during the wet season, and the dominant vegetation of these patches is sedge and tall sawgrass.

Transitional forests extend between upland forests and scrub swamp forests. They tend to occupy level areas or areas with only a shallow gradient. Cohun palm forests occur on well-drained soil in the uplands, often at the base of slopes, and may be found as patches within riparian forests. Riparian forests are swamp forests that line perennial watercourses, and this vegetation type is commonly observed along the banks of the Rio Bravo and Rio Hondo. Areas supporting riparian forests may be seasonally inundated and have deep alluvial soils. Patches of lacustrine swamp forest are found on the seasonally flooded edges of lakes or aguadas, and are prevalent around the margins of Blue Lake. Much of the area of channelized fields that extends east from the base of the scarp is typical marshland. Marshes commonly develop on wet, peaty clay, and support herbaceous vegetation. A palmetto savanna extends east of this marshland across the Rio Bravo floodplain, supporting the vast agricultural community composed of the Chan Cahal, Sayap Ha, and Sak Lu'um settlement sectors. Savannas form on wet, sandy soils overlaying a dense clay substrate. The Dumbbell Bajo is characterized as mostly low marsh forest with peripheral high marsh forest. The surrounding landscape of the western *bajos* is described as deciduous seasonal forest rich in broad-leafed, lime-loving species (Wright et al. 1959). Patches of cohune palm forest are noted west of the Dumbbell Bajo. Brokaw and Mallory (1993:19) state that the forest structure and species composition of the Rio Bravo Management Area is consistent with that of northeastern Petén and the southernmost extents of Campeche and Quintana Roo. These areas all share common topographic features, reflecting a related geological origin.

Study of Ecosystem Structure

Authors have differed in their opinions regarding forest integrity in northwestern Belize and elsewhere. Whether the present distribution of economically important species in and around Maya ruins reflects some part of the prehistoric engineered environment is an issue of debate throughout the lowlands. In the Blue Creek settlement zone, and throughout the Maya Research Program's permit area, the modern landscape structure has been significantly altered through Mennonite agricultural and pasturing practices. Land clearing has been accelerating in the area at an alarming rate for over half a century. However, it is likely that much of the area was cleared of forest cover at the time the Maya occupied the area, and recent geoarchaeological research has attempted to evaluate the extent of such clearing and the effects deforestation and soil erosion may have had on the region's carrying capacity (Beach 1998).

Distribution and Use of Economic Resources

Vegetation

Archaeobotanist Kirsten Tripplett recently completed a preliminary study of the flora and fauna in the MRP project area (Tripplett and Magaña 1999). In addition to cataloguing the various plant and animal species located within the permit area, Tripplett compiled a list of species known from ethnohistorical records to have had economic value to the ancient Maya.

Floral resources of value that Tripplett and Magaña (1999) identified in the MRP permit area by include cohune palm (*Orbigyna cohune*, Arecaceae) which is common to moist upland forests and fields and used for oils and as a source of fruit, escoba (*Crysophila argentea*, Arecaceae) which is common to Blue Lake and western *bajo* landscape and used medicinally as an anaesthetic, thatch palm (*Sabal morrisiana*, Arecaceae) which is common throughout the uplands and used as a source of thatch in residential construction, royal palm (*Roystonea oleracea*, Arecaceae) which is common to the margins of *bajos* and aguadas and used as a source of fruit, ramón (*Brosimum alicastrum*, Moraceae) which is common to hill slopes within the Blue Creek settlement

zone and used as a food source, guarumo (*Cecropia peltata*, Moraceae) which is common to disturbances and used as a diuretic, rubber tree (*Castilla elastica*, Moraceae) which is found only near the Blue Creek site core and used as a source of latex, guamo (*Inga edulis*, Fabaceae) which is found west of the Blue Creek settlement zone and used as a source of soap, logwood (*Haemotoxylon campechianum*, Caesalpinioideae) which is found near the western *bajos* and used as a source of dye, negrito (*Simaruba glauca*, Simaroubaceae) which is common in the Blue Creek site core and used medicinally to treat dysentery, gumbo-limbo (*Bursera simaruba*, Burseraceae) which is common across the region and used medicinally to treat skin infections, copal (*Protium* spp., Burseraceae) which is common to transitional forests at ecotone boundaries and used as incense in traditional ritualism, cedar (*Cedrela mexicana*, Meliaceae) which is common to field edges below the escarpment and used for lumber, mahogany (*Swietenia macrophylla*, Meliaceae) which is common to moist upland forests and used for lumber, jobo (*Spondias mombin*, Anacardiaceae) which is common to field edges and hill slopes and used medicinally, allspice (*Pimenta dioica*, Myrtaceae) which is found in well-drained upland localities and used medicinally and as a spice, chicle sapodilla (*Manilkara zapota*, Sapotaceae) which is common to riparian forests and hill slopes west of the Blue Creek settlement zone, ziricote (*Cordia dodecandra*, Boraginaceae) which is found infrequently near western *bajos*, ceiba (*Ceiba* spp., Bombacaceae) which is found in upland forests and having significant cosmological value, and ya'axnik (*Vitex gaumeri*, Verbenaceae) which is found in moist area near Blue Lake and used medicinally.

Fauna

Important faunal resources identified in the MRP permit area by Tripplett and Magaña (1999) include collared peccary (*Pecari tajacu*, Tayassuidae), howler monkey (*Alouatta villosa*, Cebidae), spider monkey (*Ateles geoffroyi*, Cebidae), jaguar (*Felis onca*, Felidae), yagouroundi (*Felis yaourundi*, Felidae), ocelot (*Felis pardalis*, Felidae), coati (*Nasua narica*, Procyonidae), white-tailed deer (*Odocoileus virginianus*, Cervidae),

and red brocket deer (*Mazama americana*, Cervidae). Stanchly's (1999) faunal analysis identified only a few of these species from midden deposits at Blue Creek, though bone preservation was generally poor and the assemblage size analyzed was minimal.

There has been no systematic study of aquatic dietary resources available in either the Rio Azul or Rio Bravo river systems. However, modern settlements have done much to damage or alter these river systems, and it is doubtful that a modern assessment of the dietary potential of these streams would accurately reflect past resource composition or abundance. Numerous fish species may have existed within these rivers, and the bones of several unidentified species have been located in midden deposits at Blue Creek. While no amphibian or reptilian remains have yet been identified to date from midden deposits at the site (Stanchly 1999), it is possible that such resources could be found in these river systems centuries ago, and were exploited by the Maya (cf. Hamblin 1984). Crocodiles (*Crocodylus sp.*) are common in the rivers today and are likely to have been numerous in the past as well, save for exploitation by humans. Crocodiles were used by the Maya as a dietary resource, but also for medicinal, clothing, and ritual purposes (Hamblin 1984: 75-76).

Important avifaunal resources identified in the MRP permit area by Tripplett and Magaña (1999) include great curassow (*Crax rubra*, Cracidae), ocellated turkey (*Meleagris gallopavo*, Phasianidae), scarlet macaw (*Ara macao*, Psittacidae), and keel-billed toucans (*Ramphastos sulphuratus*, Rhamphastidae). Stanchly (1999:118) has reported the presence of avifaunal remains within midden deposits at Blue Creek, however he was not able to identify them to the species level.

Mineralogical Resources

Mineralogical resources of importance to the ancient Maya were those that had either sumptuary value, such as jadeite and hematite, or those with utilitarian value. The Maya used tools made from myriad materials including stone, shell, bone, antler, and wood, but stone was a particularly necessary resource due to its unique suitability in manufacturing tools for use in forest clearing, raw material quarrying, architectural

construction, and various processing tasks. Monumental architecture required both well-consolidated limestone as a construction material and stone that could be flaked into the various tools used in the task of construction (Abrams 1994; Eaton 1991). Consolidated limestone is available in numerous localities above the escarpment and in few areas below it, possibly lending to the general lack of masonry architecture among settlements below the escarpment. Lithic raw material possessing the characteristics necessary for the production of flaked stone tools also occur in greater quantities above the escarpment. Such materials are often exposed through the erosion of the limestone bedrock around *rejolladas* and within arroyos, features common to the upper escarpment plateau and nearly absent from the savanna landscape that extends from the base of the scarp east to the Rio Bravo and north to Blue Creek. River channels may have been important lithic raw material source areas for the communities at the base of the escarpment.

Strategic Value of the Location of Blue Creek

Blue Creek's geographic location afforded it several important strategic advantages. First, the fertile soils of the savanna below the escarpment and the *rejolladas* of the upper plateau created a prime agricultural landscape capable of supporting intensive cultivation. In addition, the dramatic terrain variability associated with the escarpment landscape manifests extraordinary ecosystem diversity, permitting exploitation of a resource mosaic that more homogenous landscapes could not offer. Blue Creek's location was then advantageously suitable for resource intensification that incorporated risk management strategies through an ability to diversify exploitation approaches.

The importance of the Rio Hondo as a commercial corridor is well established (Guderjan 1996; Guderjan and Garber 1995). Blue Creek lies at the furthest navigable point on this river system, and thus the site may have been a terminus for goods flowing through this system and destined for consumer markets in the central lowlands. Blue Creek was also advantageously positioned to assume a pivotal role in the distribution of

luxury and utilitarian resources for much of the Maya heartland during the Classic period.

Several authors have pointed out that the Rio Bravo escarpment appears to have been not only a physical boundary, but a cultural one as well (Guderjan 1996; Houk 1997; Roys 1957). While commercial and elite interaction undoubtedly occurred between northwestern and northern Belize sites, differences in political allegiance and cultural tradition have been proposed for the two regions. Thus, by virtue of its location, Blue Creek was not only one of the easternmost bastions of the central Petén cultural tradition (and perhaps its political sphere), but it was also well-positioned as a liaison community between the two zones. From its position at the upper edge of the escarpment, the site also overlooks the northern Belize coastal plain below. The major sites of El Pozito and Kakabish lie in view to the east. Hence Blue Creek was an important frontier community (Guderjan 1996).

History of Investigations at the Site of Blue Creek

Initial Documentation and Project Development

Mary Neivens first documented Blue Creek in 1976 as part of the El Pozito project (Neivens 1991). Neivens constructed a rudimentary map of a portion of the site core, noting the ballcourt and disturbances caused by looting on most of the major structures (1991:51-52). She also recorded water sources near the ruins and discovered an artificial “ramp” leading from the site center to a cenote (1991:51). Neivens carried out salvage operations within the site core at Structure 24 (which she recorded as Structure B-I) and Structure 9 (which she recorded as Structure B-IV-2) to retrieve chronological information and record architectural phases exposed by the looting activities. Neiven’s (1991:54) concluded that Blue Creek was largely a Late Classic center heavily disturbed by looting. Future research would find that the origin of the Maya community at Blue Creek extends back to at least the Middle Preclassic period (Guderjan 1996; Haines 1999). Also, while present, looting of the site is relatively minimal. Recent research has better defined the extent of the Blue Creek community,

enabling a better understanding of its scale and complexity in comparison to other sites in northwestern Belize and throughout the Maya lowlands.

Following its initial recording by Neivens, Blue Creek was next investigated by Guderjan during a reconnaissance survey of Maya settlement in northwestern Belize, although no further work occurred at the site at this time (Guderjan 1991). Guderjan and Garber (1995) had previously investigated Maya settlement and trade at Ambergris Caye, and Blue Creek's location at the westernmost navigable extent of the Rio Hondo river corridor made the site an attractive locality at which to continue investigating prehispanic Maya trade networks (Guderjan et al. 1994:1; Guderjan 1996:5; Guderjan and Driver 1996:1).

Guderjan initiated extensive archaeological investigations at the site in 1992 under the auspices of the Maya Research Program. Research during the first season was devoted principally to mapping, with small test excavations placed within the site center. Extensive excavations of structures in the site center were carried out the following year, with investigations focused on the dispersed settlement community being undertaken in subsequent seasons.

Archaeological investigations at Blue Creek have been conducted by a great many researchers since the project's beginnings. This diversity has brought many contrasting and complementary skills and perspectives to the project, from which research at the site has greatly benefited. However, one issue that has arisen from this diversity is the lack of a standardized archaeological methodology. To some degree this has undermined the certainty with which materials collected from the various excavations carried out at the site can be effectively compared. Many investigation strategies were directed toward documenting architectural features and construction stratigraphy, and the extent to which natural soils, sediments, and cultural deposits were screened for small artifacts is not consistently addressed in field notes. However, Blue Creek is not unique in this regard. Archaeology in the Maya lowlands could benefit substantially from more rigorous standardization of field and laboratory methods.

Excavation Localities

The Blue Creek site center is located on a prominent rise atop the Rio Bravo escarpment (see Figure 4). Architecture of the Blue Creek site core is comprised of two primary architectural complexes (Figure 11). The first complex, Plaza A, includes several public and residential structures situated around a large plaza, and there is a ball court on a large raised platform at the northern end of the plaza. The tallest structure in this group, Structure 1, rises 14 meters above the artificial platform on which it rests. Excavations below the plaza into the platform have yielded evidence of Middle Preclassic occupation, though no architectural remains from this early period have been recovered. The second complex, referred to as Plaza B, is composed of several large residential, public and/or ritual structures organized in a north-south linear configuration.

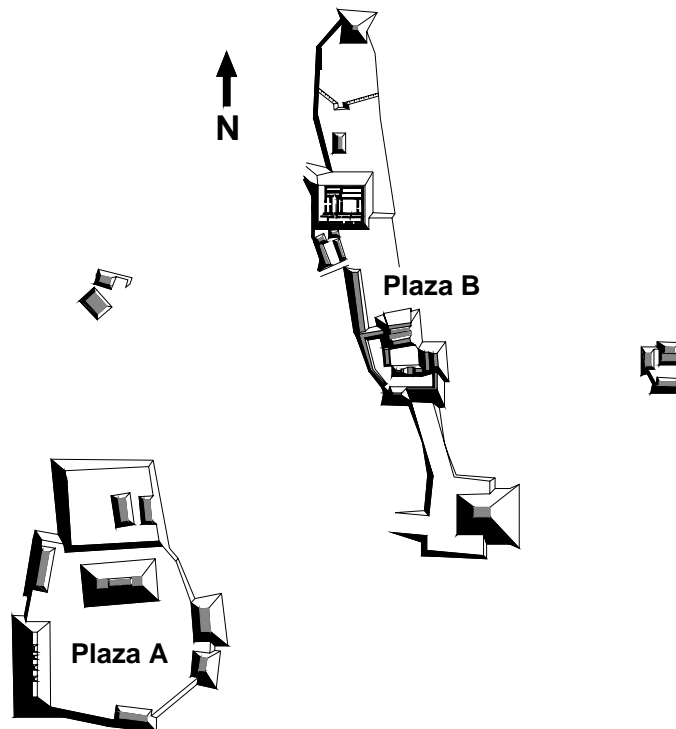


Figure 11: Architectural configuration of the Blue Creek site core (adapted from Guderjan 1986).

Major landscape modifications in the site core appear to have been initiated early in the Late Preclassic period, and much of the large public and residential architectural construction in this central area dates from the Late Preclassic through to the Early Classic period. While architectural modifications to Plaza A seem to have been largely complete by the end of the Early Classic period, architectural modifications to several of the structures located in Plaza B appear to have continued into the Late Classic period (Driver, et al. 1997; Guderjan 1996; Guderjan et al. 2003; Haines 1999).

Western Group Elite Residential Zone

The cluster of impressive elite residential and administrative architecture that comprises the Western Group is situated on the next prominent topographic rise to the north of the site core (see Figure 4). The arrangement of plazas and plazuelas that make up the Western Group seems to be largely an extension of elite settlement beyond the main core area, and may have been only functionally differentiated from the core, with little or no difference in the socio-political status of residents. The site core would have served as the civic and ceremonial nexus of the polity, while the Western Group served principally as a high-status residential precinct. Significant construction in the Western Group seems to have initiated in the Early Classic period, with massive Late and Terminal Classic expansion thereafter (Guderjan, Lichtenstein, et al. 2003).

Rosita

The portion of the Blue Creek community known as the Rosita group lies at the far north of the settlement zone as it is currently understood (see Figure 4). Initial investigations suggested that Rosita represented a separate political entity from Blue Creek (Guderjan et al. 1991:85). However, continued excavations outside Blue Creek's central precinct have documented a continuum of settlement between the site core and the Rosita community, and there is currently no reason to believe that the areas represent distinct political domains.

Architecture at Rosita resembles that of the Western Group in complexity and general configuration, and the two areas may essentially represent functionally equivalent elite residential communities. If this is accurate, there is a clear trend in the clustering of elite residential architecture above the escarpment on prominent hills. Cultural materials recorded at Rosita through surface collection and minor excavations suggest that initial architectural development dates to the Late Preclassic period, and that significant developments took place through the Late Classic period (Lichtenstein 2000). However, investigations in this portion of the Blue Creek settlement zone have been minimal and little is actually known about this sector of the community.

Chan Cahal, Sayap Ha, Sak Lu'um and Rio Hondo

The floodplain of the Rio Bravo extends east from the base of the escarpment to the present river channel. A network of interconnected fields, channelized by the ancient Maya, radiates from the base of the escarpment (discussed below). In the savanna extending from the eastern periphery of this field system is an extensive agricultural community. Initial survey of this residential community distinguished several discrete communities on the basis of the distribution and density of house mounds. While present investigations at the site continue to refer to general areas of this settlement zone by these initial distinctions, it is becoming increasingly clear that the settlement was not separated into discrete communities. Recently completed surveys have looked at this zone more intensively and show settlement to have been much more continuous than previously thought. In addition, excavations have shown that occupation throughout the zone was not chronologically continuous, suggesting a much more dynamic pattern of settlement than was previously imagined.

Chan Cahal lies at the northern periphery of the principal savannah settlement zone along the margin of the channelized field network. Archaeological investigations at Chan Cahal were initiated during the 1996 field season (Clagett 1997) and continued through the 2000 field season. Early Formative deposits have been recovered from this area, though most of the architecture dates to the Late Preclassic period. A substantial

expansion of the main architectural complex at Structure U-5 occurred during the Late Classic period (Giacometti 2002).

Sayap Ha consists of settlement along the central periphery of the channelized field margin. Initial investigations at Sayap Ha were conducted during the 1997 and 1998 field seasons (Lichtenstein 2000), with intensive investigations taking place during the 2001 and 2002 seasons. The earliest deposits in this area date to the Late Preclassic period, although the most intensive architectural expansion occurred in the Early and Middle Classic periods (Giacometti 2002). Sayap Ha appears to have been abandoned sometime in the seventh century AD, with no evidence to suggest that the area remained occupied into the Late Classic period. Like Chan Cahal, Sayap Ha is dominated by small house mounds of near identical configuration (Lichtenstein 2000). However, both areas also display at least one structure of significant architectural elaboration that may have been a center of public ceremony or administration.

The southern-most area in the savanna community is referred to as Sak Lu'um. Minimal excavations were carried out in this area during the 1997 field season, yielding evidence for the area being inhabited from the Late Preclassic through Late Classic periods. Lichtenstein (2000:59-60) reports that there are approximately 44 structures in this zone, informally organized into 4 patio groups and a number of isolated house mounds.

Archaeological investigations were initiated during the 2002 field season on a small cluster of house mounds that is located further to the east along the Rio Hondo flood plain called the Rio Hondo settlement. This architectural cluster has no apparent relationship to the channelized field network, and appears to represent non-elite settlement at the eastern margin of the Blue Creek polity.

Additional Areas of Archaeological Interest in the Blue Creek Settlement Zone

Tom Guderjan, David Driver, and Pam Weiss initially identified the extensive network of channelized agricultural fields that extend from the base of the scarp east to the elevated limestone ridge on which the savanna settlement community is situated during the 1995 field season (Guderjan 1996: 2-3; Figure 12). Photographic documentation of the fields via aerial reconnaissance was completed at this time. The extent of channelized field construction was not well understood, however, until more extensive aerial investigations were carried out in 2001 and 2002 (Lohse et al. 2003). Archaeological excavation of the ditched fields was initiated by Jeff Baker during the 1996 field season (Baker 1997). More ambitious investigations of these features began during the 2001 field season, conducted by Tim Beach of Georgetown University (Beach and Luzzadder-Beach 2004). Beach's research has focused on determining the chronology of field construction, developing an understanding of area hydrology through time, and determining the extent to which natural and cultural transformation process have affected the present morphological characteristics of the channelized field system.

Investigation of water control features across the Blue Creek landscape was initiated during the 1999 field season by Alex Mullen. Several check dams were found at strategic locations across the rolling terrain of the escarpment surface, and undoubtedly served to retard soil loss resulting from rain erosion. Similar features have been reported from elsewhere in the Maya lowlands (Figure 13; Turner and Johnson 1979; Healy 1983; Healy et al. 1983).



Figure 12: Channelized agricultural fields extending from the base of the Rio Bravo escarpment (view SE, photo courtesy of Kim A. Cox).

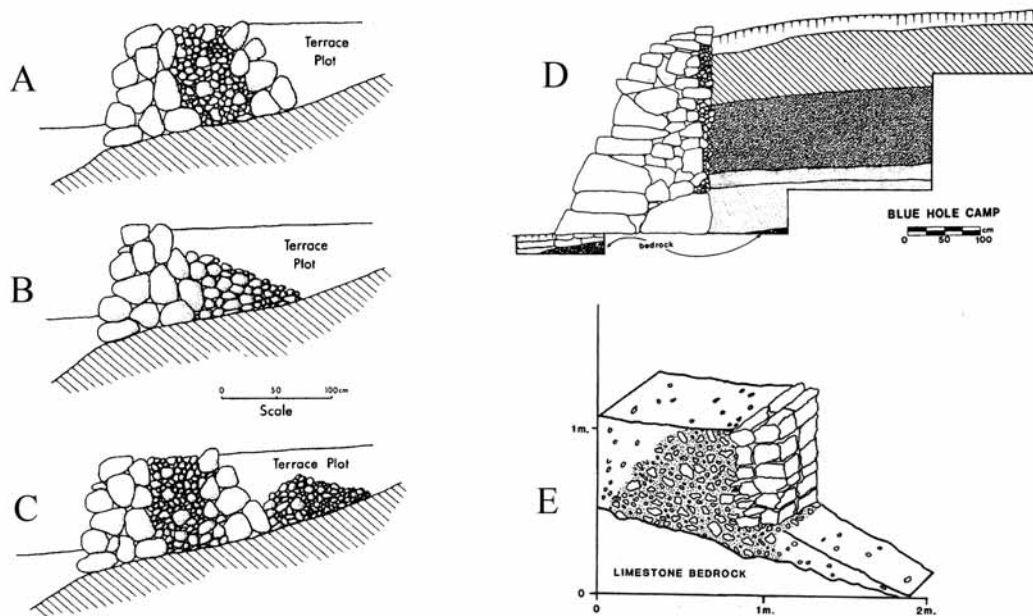


Figure 13: Maya upland terrace walls and dam features. A-C Caracol (adapted from Healy et al. 1983); D Blue Hole Camp (adapted from Healy 1983); E Rio Bec (adapted from Turner 1983).

Areas of Archaeological Interest in the Environs of Blue Creek

An ancient Maya riverine architectural complex comprised of a stone dock, weir system, and dam was discovered during the 2000 field season on the Rio Azul, north of the Blue Creek settlement zone (Barrett and Guderjan 2004). The feature complex was constructed along a natural terrace emanating from the Belize bank of the river. The feature was constructed of moderate-sized limestone cobbles, likely transported from further upstream. Archaeological investigations were concentrated along the Belize bank between the dock and dam, within the stream channel west of the dock, and within the stream channel west of the dam (Figure 14). Although no cultural materials or traces of architecture were discovered along the riverbank, a large quantity of lithic manufacturing debris was recovered from the river channel, along with several aborted bifaces in various stages of manufacture. The architectural dimensions of the feature were recorded and mapped using tape and compass techniques.

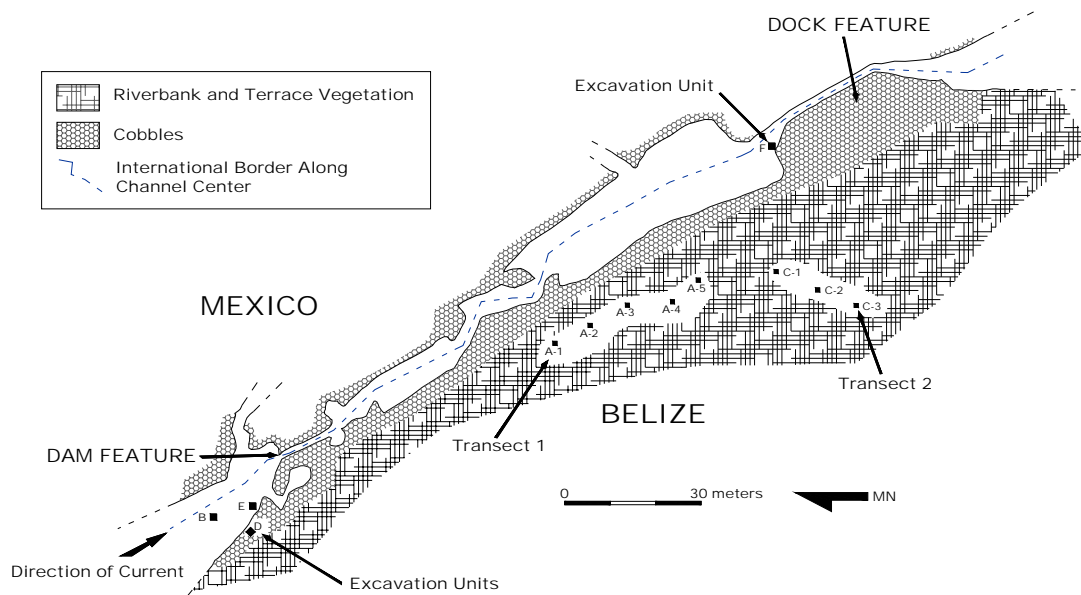


Figure 14: Maya dock and dam located on the Rio Azul north of the Blue Creek settlement zone.

The site of Ixnoha is approximately 14 kilometers northwest of the Blue Creek site center (see Figure 5). Ixnoha was first recorded by Guderjan in his settlement survey of northwestern Belize (Guderjan et al. 1991). The site was subsequently “rediscovered” by the Maya Research Program in 2001, and excavations were undertaken during the 2002 season (Gonzalez 2004). The site was found to be considerably larger than previously imagined, and is currently believed to represent an independent polity similar to Blue Creek in size and complexity. The total extent of the Ixnoha settlement zone is not currently well understood, and there has yet to be any systematic attempt to determine the architectural and occupational chronology of the site. Considerable recent looting of monumental architecture at the site center was noted during the 2002 field season.

The site of Bedrock is located at the northern margin of the Dumbbell Bajo, adjacent to the main road running west from the escarpment edge (see Figure 5). It was

first documented by the Maya Research Program during the 1993 field season (Guderjan et al. 1994:46), after the area on which it is situated had been cleared of all vegetation by a bulldozer and chain. The modern Mennonite farmers in northwestern Belize practice his method of land clearing. The practice has devastated the archeological remains of architecture and settlement features across the project area, and the Bedrock site is no exception. The site was so named due to the barrenness of the landscape it was found on, owing to the recent landscape modifications by Mennonite farmers. Little is currently known of the Bedrock site, and it is not known whether the site represents an independent polity or whether it is part of a larger Ixnoha polity. Salvage operations of an exposed tomb were carried out during the 1999 field season, and an operation aimed at determining construction chronology was undertaken in 2001 (Guderjan 1991; Guderjan et al. 1994:46; Barrett 2001).

A lithic workshop was discovered on a peninsula of land that reaches south into the Dumbbell Bajo approximately 1.5 kilometers southeast of the focal architectural group of the Bedrock site (Figures 15 and 16) (Barrett 2001). Large tabular slabs of chalcedony were discovered on the peninsula, making the locality an important source area for lithic raw material procurement, and evidence of stone tool manufacture was discovered at several loci. Excavation of the workshop took place during the 2001 field season, and the findings are central to the present study. A single mound approximately 2 meters in height is located at the eastern end of the formation, and a modest courtyard is located at the western end.

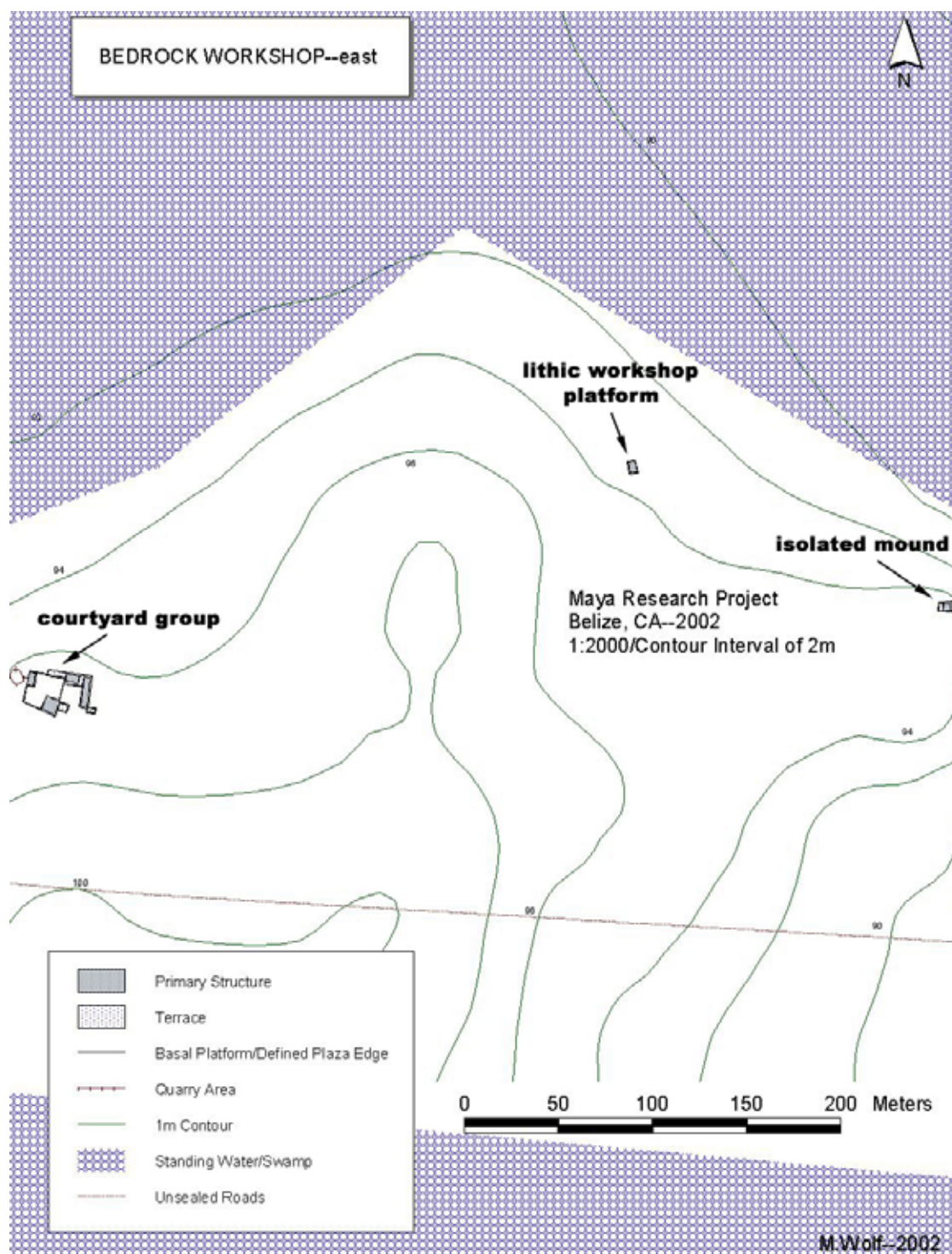


Figure 15: Architecture proximal to the lithic workshop located near the site of Bedrock in the Dumbbell Bajo (mapped by Marc Wolf and Kristen Gardella).



Figure 16: Architecture features of the central Dumbbell Bajo including the Bedrock lithic workshop and Sotohob courtyard (view south, photo by author).

The Sotohob courtyard is located at the northern margin of the Dumbell Bajo, approximately 2 kilometers east of the Bedrock site center, just over 1 kilometer northeast of the Bedrock lithic workshop. The name Sotohob is an acronym representing “site on top of hill overlooking *bajo*”, which is a fairly accurate description of its position of the landscape. Excavations at this locality were undertaken during the 2002 field season and are an important component of the current work. The Sotohob courtyard is of comparable architectural complexity to that documented to the immediate west of the Bedrock lithic workshop (Figure 16), allowing for a comparison of resource utilization based on proximity to a raw material source.

Analysis of Archaeological Features and Materials

Few analyses have been completed to date for any material class recovered by the MRP at Blue Creek, though several are underway and are scheduled to be published in a series of research monographs by Texas Christian University Press (Guderjan 2003, personal communication). Below is a synopsis of the analyses currently being completed as presently known to this author.

Settlement Survey

Initial survey of the Blue Creek settlement zone was undertaken by MRP staff member Robert Baker. Baker's settlement map was later added to through additional survey work performed by Robert Lichtenstein (2000), who recently completed a master's thesis at Boston University describing the greater Blue Creek settlement zone. In this work Lichtenstein employs site data and various settlement models to chronicle the general patterns and sequences of occupation at Blue Creek from the Middle Preclassic through Postclassic periods. His work provides a good general overview of the spatial distribution of architectural elements and features, though its rigid definition of community boundaries does little to elucidate the social interconnectedness that likely existed between individuals and groups across the landscape.

A new survey of the MRP permit area, including the Blue Creek settlement zone, was initiated during the 2001 field season by Marc Wolf and Kristen Gardella. The purpose of this new survey was to increase the resolution of cultural features distributed across the landscape, and to incorporate Blue Creek into the broader context of ancient Maya settlement in northwestern Belize. Wolf and Gardella's map indicates that the Blue Creek settlement zone is characterized by greater settlement density than had been previously realized, and shows low, broad platforms in many "between-space" areas (Figure 17). This comprehensive map, made possible in part by accelerated deforestation and the use of modern survey equipment, shows the Rosita community to be much larger and more complex than previously imagined. Also, Wolf and Gardella's survey shows the settlement zone at the base of the escarpment to be characterized by a

continuum of settlement rather than being composed of distinct, nucleated communities. This new, more accurate settlement map provides a richer baseline for understanding the dynamics of community patterning.



Figure 17: "Between-space" features within the Rosita precinct of the Blue Creek community (photo by author).

Architecture

The majority of architectural documentation at Blue Creek has been delivered in various interim volume reports (Driver and Wanyerka 2002; Guderjan 1996; Guderjan et al. 2003). The nature of these reports was mainly to inventory findings and record excavation procedures, and little formal or comparative analysis was attempted in them. David Driver has recently published his findings from excavations on the Early Classic colonnaded superstructure of Structure 1 (Figure 18); he links its architectural form to

similar traditions found throughout the northern and southern lowlands (Driver 2002:79). Driver concluded that the colonnaded superstructure of Structure 1 represents a variant of a portico gallery that functioned as an observation platform for public spectacle.

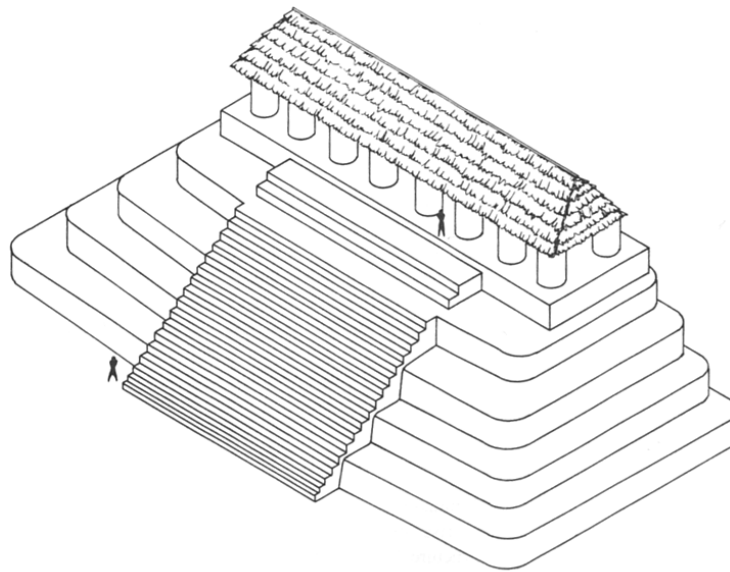


Figure 18: Reconstructed isometric view of Structure 1 at Blue Creek (drawings by W. David Driver, from Guderjan and Driver 1999, Figure 5).

Ceramics

Laura Kosakowski initiated a systematic analysis of the ceramic complexes at Blue Creek and throughout the MRP permit area in 2000. This work is on-going, but has already made significant contributions to a more holistic understanding of intra- and inter-community patterns of interaction. Also, the ceramic analysis provided by Kosakowski has enabled the construction of a comparative chronology of site occupation and ceramic trends through time, placing these processes at Blue Creek into generally recognized lowland Maya time periods (Figure 19).

Time Period	Calendar Years (approximate)	Blue Creek Ceramic Complexes	Regionally Comparable Complexes
Terminal Classic	AD 850 – 1000	Booth's River	Tepeu 3
Late Classic II	AD 750 – 830/850	Dos Bocas	Tepeu 2
Late Classic I	AD 600 – 750	Aguas Turbias	Tepeu 1
Early Classic	AD 250 – 600	Rio Hondo	Tzakol (1, 2, 3)
Terminal Late Preclassic	AD 100/150 – 250	Linda Vista	Floral Park
Late Preclassic	350 BC – AD 100/150	Tres Leguas	Chicanel
Middle Preclassic	650 BC – 350 BC	Crystal Creek	Mamom
Early Middle Preclassic	1000/800 BC – 650 BC	Cool Shade	Swasey, Bladen

Figure 19: The Blue Creek ceramic complexes.

Obsidian

The analysis of stone artifacts in the present dissertation is limited to non-obsidian, flaked stone tools. This coincides with the long-standing tradition within Maya archaeology of artificially constructing analytical categories and endowing them with variable worth regarding their ability to inform dynamic social processes. Thus, obsidian, groundstone, and jade, though “lithic” in character, and related in their ability to provide important systemic information when considered together rather than separately, are removed from the present analysis.

The analysis of obsidian recovered at Blue Creek was undertaken by Helen Haines as part of her dissertation research at University College of London (2000). Haines focused on illustrating the distribution and consumption of obsidian on an intra-site scale in an attempt to establish whether or not variation in the use of obsidian from divergent resource nodes might be attributed either directly or indirectly to contextual variations. She defined variations in context as functional, archaeological and social. Haines compiled data relating to obsidian consumption from ten sites and two survey areas, covering four geographic regions across northern Belize and northeastern Petén, Guatemala. To date, Haines has produced the only analysis of Blue Creek obsidian. Although a large quantity of obsidian was apparently recovered at Structure 24 by Mary

Neivens during her initial exploration of the Blue Creek ruins in 1976 (Neivens 1991), she has not published an analysis of her findings.

Groundstone

Groundstone artifacts, including manos, metates, bark beaters, and stucco polishing stones have been recovered in some quantity from excavations in the Blue Creek settlement zone, though they have only recently been analyzed and reported (Esquerda 2003). Local limestone, quartzite, and dolomite were used in the construction of many of these pieces, although several examples of imported pieces constructed of basalt and granite have also been recovered (Figure 20). The temporal and spatial distribution of local and exotic forms should prove to be an informative contribution toward the understanding of elite-commoner interaction and extra-regional economic integration at Blue Creek.



Figure 20: Imported granite metate and travertine mano (possibly local material) recovered at Blue Creek (photo by Bill Collins).

Jade

MRP staff member Dale Pastrana has made the most significant contribution toward the analysis of jadeite artifacts recovered at Blue Creek (Pastrana 1999). Guderjan has noted that the amount of jade recovered at Blue Creek is extraordinary given the size of the site, and he attributes this to the site's advantageous position on the circum-Caribbean trade route (Guderjan 2002). The shaft cache discovered at Structure 4 contained the third largest deposit of jade artifacts found in the Maya lowlands (Figure 21; Guderjan 1998, 2001). Typically rare, jade artifacts are so prevalent in Early Classic deposits at Blue Creek that even simple house mounds in the agricultural sector often yield jadeite beads and inlays. The importation and circulation of vast quantities of jade at the site seems largely to have been an Early Classic period phenomenon, however. Only a very small number of jadeite artifacts have been recovered from Late Classic period deposits.

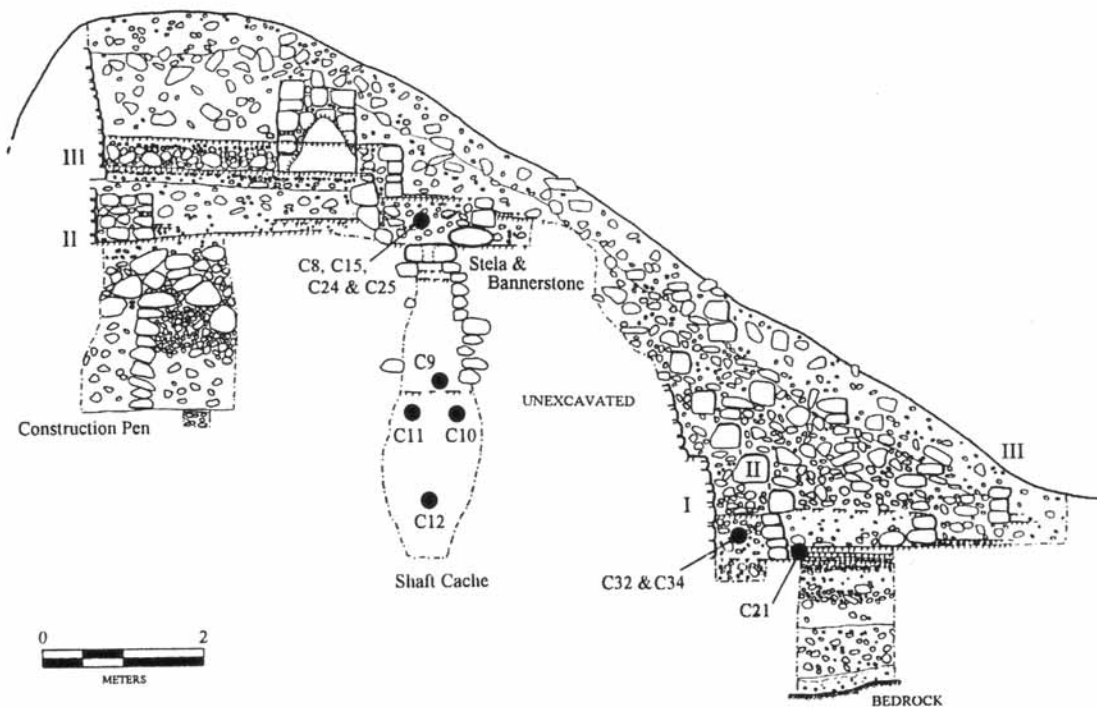


Figure 21: Structure 4 shaft cache (adapted after Driver 1999, Fig. 13).

Small Finds

The analysis of artifacts typically categorized as “small finds” constitute an important and frequently overlooked avenue of research. This artifact category includes objects such as ceramic whistles, spindle whorls, shell beads, bone artifacts, personal ornamentation, and other miscellaneous, artistic forms. Many of these artifacts relate to aspects of folk-culture and offer important insight toward discerning the larger traditions and cultural affiliations to which sites adhere. As archaeologists debate to extent to which lowland Maya populations were socially and politically integrated, the study of folk traditions, as reflected in these small, artistic media, remains saliently absent (but see Buttles 2002). The analysis of “small finds” remains an important and productive avenue for future research at Blue Creek.

Plant Residues

John Jones of Washington State University has conducted pollen research throughout lowland Mesoamerica, and began research at Blue Creek during the 2002 field season. Jones’ ongoing research addresses environmental change resulting from human settlement and subsistence pursuits, cultigens associated with Blue Creek’s channelized field system, and ecosystem resilience. The results of his research are forthcoming.

Human Osteology

David Glassman of Southwest Texas University has performed the osteological analysis of human skeletal remains recovered in the Blue Creek settlement zone. Glassman has not yet published the results of his analysis, but is currently working on the production of a monograph detailing his findings. Human burials have been reported in several excavation reports in the Maya Research Program’s *Working Papers* series, which include illustrations and detailed contextual descriptions. To date, however, there is no information available on the diet and health of Blue Creek’s resident population.

Fauna

Very little has been reported on analysis of faunal remains from excavations at Blue Creek to date. Norbert Stanchly (1999:115-121) has published a preliminary analysis of remains recovered during the 1996 and 1997 field seasons. The assemblage size he studied was extremely small and poorly preserved, however, and little can be said regarding spatial and temporal patterns of dietary resource exploitation at the present time.

Steve Bozarth of the University of Kansas began analysis of phytoliths during the 1999 field season. Bozarth's research on the content of ritual caches suggests that marine sponges may have been an important element of these deposits (Bozarth and Guderjan 2003). Many lip-to-lip caches found throughout the Maya lowlands have contained marine elements such as stingray spines, coral, and various varieties of shell (*Spondylus* having the greatest sumptuary value), thought to symbolically recreate the watery underworld of Maya cosmology (cf. Coggins, et al. 1983). Bozarth's finding of marine sponge residues within several such cache offerings coincides with the aquatic theme prevalent within such deposits, and may illuminate an important element of Maya blood ritual.

Caches

At Blue Creek, caches are typically found in association with architectural features, and generally conform to patterns well-established throughout the Maya lowlands (Chase and Chase 1998; Coe 1965). Several significant cache deposits have been discovered at Blue Creek, though a synthetic comparison of these features is yet to be completed. Notable deposits include the Structure 4 jade cache (Guderjan and Driver 1999; Guderjan 1998) and the Structure 34 lithics cache (discussed in more detail in Chapter V below; see Figure 21).

Stone Tools and Lithic Raw Materials

An initial assessment of lithic resource procurement and consumption in northwestern Belize was completed by Lindeman and Guderjan (1991) as part of the Rio Bravo Archaeological Project. Based on the inspection of several streams near the sites of Chan Chich and La Milpa, and the discovery of several areas where production of local materials seems to have taken place, Linderman and Guderjan concluded that “adequate resources seem to have existed locally to supply the resident Maya populations”, and further that “it is dubious that procurement would have occurred on anything other than the household level” (Linderman and Guderjan 1991:97). These assertions will be readdressed in Chapter V below, but it is worthwhile to mention here that lithic raw materials are not distributed homogenously, and the areas observed by Linderman and Guderjan happen, by chance, to be some of the most productive resource nodes in the region. As shown in the chapters that follow, Blue Creek seems to have been extremely reliant on imported stone tools through its occupation history.

Cox and Ricklis (1999: 85) produced the first analysis of stone tools at Blue Creek, concluding that “the general range of lithic tool types found in the Blue Creek area is limited in forms, and are largely (if not entirely) of local production”. Again, these conclusions will be addressed in the chapters that follow, but it is worthwhile to note here that at no point in time do more than about 20% of tool forms recovered at Blue Creek appear to have been manufactured at the site itself (see Chapter VI), and the range of tool forms recovered is comparable to that reported for sites throughout the lowlands.

The relationship between Blue Creek and its neighbors, as well as between Blue Creek and more distant sites, can be observed through a comprehensive analysis of raw material properties of tool forms. The distribution of lithic resources is not uniform throughout the MRP permit area, nor is the character of raw materials comparable between source areas. Thus, discrete resource nodes can be discerned, and Blue Creek’s reliance on external material source areas may be evaluated.

The impetus for the importation of stone tools from external resource zones lies in the nature of the lithic materials available within the Blue Creek settlement zone. Few resources that could support the manufacture of flaked stone tools are available below the escarpment, with the best quality material being found in Rio Azul channel deposits. Cobble sizes tend to be small, however, limiting their general utility. Several dolomite deposits have been noted on the upper escarpment face, and a small percentage of tool forms were constructed of this material. However, dolomite has unpredictable fracture planes and is not easy to flake. Moreover, resharpening is difficult, if possible at all. The labor requirements of initial production, coupled with the low potential for curation, certainly prohibited anything more than occasional exploitation of this resource. The upper escarpment plateau has also yielded several outcrops of sedimentary quartzites and coarse-grained cherts. The most productive outcrops of these materials are found in association with the small *bajos* in and around the Rosita community (see Appendix B), and within the dry arroyo west of the site core. Neither resource is ideal for flaked tool manufacture, and most tools constructed of these materials were heat treated.

Material resources associated with the Dumbbell Bajo are of much higher quality. Most silicious outcrops can be classified as either chalcedony or fine-grained chert. These materials are not only more workable, but have longer use trajectories as a result of their superior capacity for rejuvenation. Possibly reflecting this concern for curation potential, and specifically with regard to utilitarian forms, a large number of tool forms were imported from the northern Belize chert-bearing zone (NBCZ). With intensive production centralized at the site of Colha (Hester and Shafer 1994; Shafer and Hester 1991), tool forms from this area have been recovered from many sites throughout the lowlands, and are generally recovered at Blue Creek in a highly recycled state (Figure 22; Dockall and Shafer 1993; McAnany 1988; Shafer 1983).

By developing an understanding of the heterogeneity of lithic resources within the Blue Creek settlement zone, across northwestern Belize, and throughout the Maya lowlands, an assessment of internal self-sufficiency and external reliance may be achieved. This analysis of flaked stone tools contributes both to an evaluation of how

economic resources were managed within the Blue Creek community, and an appraisal of Blue Creek's involvement in inter-polity resource exchange. The scale to which local resources could be internally monopolized by the site's elite also reflects on the greater scale of site autonomy and dependence that Guderjan thought to question over a decade ago.



Figure 22: Recycled Colha tool forms recovered in excavations at Blue Creek.

In addition to providing a more comprehensive analysis of lithic procurement and consumption patterns at Blue Creek than has previously been offered, the present study directly addresses many of the long term research goals of the Maya Research Program's investigations at the site of Blue Creek. As stated by Guderjan et al. (1994:1), these goals include expanding the regional database on archaeological sites of moderate complexity in northwestern Belize, testing whether Blue Creek was a "daughter site" of a larger political entity, examining the apparent interactive dynamics between the Petén and northwestern Belize, and assessing Blue Creek's possible "function" with regard to inter-polity trade.

Occupational History of Blue Creek

Dating Methods Employed at Blue Creek

A number of methods have been used by Maya archaeologists for the purpose of dating cultural materials and features. Radiocarbon dating has had mixed results in the Maya lowlands because of generally poor preservation conditions and the lack of a suitable tree species for dendochronological cross-referencing. Due to concerns for its accuracy in this region, and the expense associated with the method, ceramic chronologies are frequently relied upon. However, ceramic chronologies have variable degrees of sensitivity across the lowlands, and researchers have sought independent methods to date deposits. Radiocarbon assays have been completed for select contexts within the site core at Blue Creek, but have not been consistently used throughout the site. Obsidian hydration has produced equivocal results when applied (Anovitz et al. 1999), and pilot studies using Blue Creek obsidian have not provided consistent results (Kim Cox, personal communication). The ceramic analysis conducted by Laura Kosakowski, described above, currently serves as the principal method of dating archaeological deposits at the site.

The Preclassic Period at Blue Creek

The earliest evidence for occupation at Blue Creek dates to the early Middle Preclassic period (800-350 BC). Cultural materials from this period have been recovered from both the plateau above the escarpment and from the savanna below it. There is currently no evidence to suggest that Blue Creek was a structurally differentiated community at this point in time as no architecture survives from this period. Guderjan (1996: 8) has suggested that Blue Creek was likely a small nucleated village during the Middle Preclassic. More accurately, Blue Creek was likely an integrated, yet diversified community at this time, whose occupants exploited the divergent microenvironments offered by the Rio Bravo escarpment.

As there is little of Blue Creek's Middle Preclassic community represented in the archaeological record, the socio-political structure of the community cannot be

adequately assessed for that period. Hammond's work at Cuello supports the inference that individuals in Middle Preclassic communities were unstratified, differentiated only by rank (Hammond 1991). Research at Nakbe in the northern Petén, however, suggests that at least some communities expressed incipient stratification during this period (Hansen 1992). While Blue Creek appears clearly unstratified at this time, it is likely that the inequality observed in later periods had its foundation in the developing cultural institutions at this early time in Maya prehistory.

Blue Creek's site core emerged on the upper escarpment plateau during the Late Preclassic period, becoming the community's nucleus of civic and ceremonial ritual. The massive platform on which Plaza A rests was constructed early in this period, with the aggregation of the structures on its surface continuing through the mid third century AD. The linear configuration of Plaza B was also established at this time, and many of its prominent structures were first constructed then (Guderjan 1996). Currently, there is no evidence to suggest the presence of substantial Preclassic settlement on the escarpment plateau outside of the site core. Excavations in the Western Group and the Rosita areas have yielded some indication of Preclassic occupation, but neither area appears to be well-developed at this time (Clayton 1994; Guderjan et al. 2003). Although Late Preclassic settlement of the escarpment plateau currently appears to have been spatially limited, many significant architectural features have yet to be adequately explored, and the presence of significant settlement cannot be ruled out.

Based on ceramic evidence, settlement in the savanna zone at the base of the escarpment proliferated during the Late Preclassic period, and the initial construction for most structures dates to that time (Giacometti 2002). There appears to be little differentiation within the savanna community during this period; no discernable "central place" emerged within the settlement zone. All construction within the zone was characterized by irregular arrangements of small mounds that would have supported perishable superstructures.

The Late Preclassic community at Blue Creek exhibited the foundations of institutionalized inequality. The elites of the site core were set apart from an otherwise

little differentiated community, and the manifestation of their greater entitlements at this time is observed in the grandeur of architecture at the site center. Commodities from both regionally available and exotic resource zones occur frequently throughout the community at this time, both as luxury items and to reconcile local resource deficiencies. The vast majority of imported stone tools are utilitarian forms, found in both elite and non-elite contexts. The greater entitlements enjoyed by elites may have resulted from their role in managing a diversified local economy, and through articulating a provisioning network by the creation and maintenance of stable external relationships.

The Classic Period at Blue Creek

Architecture in the site core exhibits attention to stylistic innovation during the Early Classic, and it achieved profound developmental complexity. Plazas A and B were fully laid out during the Early Classic. Two large stucco mask panels dating to this period were discovered on Structure 9 (Figure 23; Guderjan 1996; Guderjan et al. 1994). It has been suggested that these represent early “Ahu” iconography, indicative of Blue Creek’s status as a politically autonomous polity (Grube, et al. 1994; Guderjan 1996). The remains of an elaborate ritual cache, dated to the end of the Early Classic period, were located in Structure 4. An enormous amount of jade was found within the cache, along with several lip-to-lip ceramic offerings, a large, four-pointed star eccentric from a Colha workshop, and various other objects (Guderjan 1998). Guderjan (1996: 15) has suggested that the Early Classic period (AD 250-600) represented the apogee of Blue Creek’s autonomous political development, and that political and economic structure thereafter reflected geopolitical processes that may have exerted influence over much of the Three Rivers Region.

Settlement in the savanna landscape below the escarpment also exhibited structural differentiation during the Early Classic period, with the emergence of complex architectural groups that may have functioned as central places for civic and ritual activities. The extensive network of channelized fields at Blue Creek that extends between the base of the Rio Bravo escarpment and the savanna community may date to this period. Research into the origin and characteristics of these features is ongoing (Beach and Luzzadder-Beach 2004).

In terms of community structure, several important developments date to the Late Classic period. First, there was a proliferation of non-elite residential house mounds across the upper escarpment plateau, as well as an expansion of elite courtyards on elevated terrain north of the site core. Little aggrandizement within the site core is observed at this time, though several structures were converted from civic-ceremonial space into residential space (Guderjan 1996; Guderjan et al. 2003). On the savanna landscape below the escarpment, some sectors of the community experienced a rapid decline and partial abandonment, while others came into prominence. While a massive “termination deposit” of Early Classic ceramics covered the central structure in the Sayap Ha sector of the savanna zone (Clayton et al. 2002; Giacometti 2003), indicating its late sixth century abandonment, Structure U-5 in the Chan Cahal sector was modified into an elaborate ceremonial structure replete with a corbelled arched ceiling (Giacometti 2002).



Figure 23: Stucco mask panel discovered on Structure 9 façade, Blue Creek (Photo courtesy of Bill Collins).

The Late Classic period occupation at Blue Creek exhibited the greatest diversity in settlement structure, as well as the highest estimated population of any period (Guderjan 1996; Guderjan et al. 2003; Lichtenstein 2000). Using settlement complexity as a proxy for social structure, the polity likely experienced the greatest expansion in the complexity of socio-economic relationships between community members during the seventh through ninth centuries. The structure of the Late Classic community cannot be

easily understood through strict adherence to a simple elite/non-elite social dichotomy. Although this remains to be explored more fully, the hierarchy of relations during this period is likely to have incorporated groups more accurately viewed as sub-elites and privileged commoners.

The Postclassic Period at Blue Creek

There is currently little evidence to suggest that Blue Creek was occupied during the Postclassic period. No architectural remains have been identified from this period, and ceramic types diagnostic of the Postclassic have not been recovered. The only evidence to suggest a post-ninth century presence comes from lithic data. Several side-notched arrow points have been recovered, and this form is generally found no earlier than the tenth or eleventh centuries in the lowlands (see Appendix A). Also, a triangular biface made of northern Belize chert zone (NBCZ) material was recovered in a disturbed surface deposit. This tool form was not manufactured at Colha until the late facet of the Early Postclassic period (see Appendix A; Hester 1985). Aside from these minimal finds -none of which was recovered from a secure context- unequivocal evidence for Postclassic occupation is absent. While modern landscape modification has certainly had a significant impact on superficial deposits, the lack of diagnostic ceramics even within disturbed contexts suggests that any Postclassic presence at Blue Creek was impermanent and informal.

The Colonial Period to the Present at Blue Creek

Belize was one of the last strongholds of Maya independence. The Maya of Chetumal successfully resisted Spanish dominion, and Belize became an area of refuge for Maya trying to escape Spanish tyranny in Yucatan (Jones 1998). The Spanish never attempted a permanent settlement in Belize, but their presence was still felt. Approximately 85% of Maya living in the area are thought to have died within a century of Spanish contact as the result of European diseases and warfare (Leslie 1997).

The British began to settle in British Honduras in the middle of the seventeenth century AD. English privateers had occupied the waters of the Caribbean for some time, harassing Spanish shipping. In 1670 AD, Spain and England signed the Treaty of Madrid in which England agreed to cease privateering in the Caribbean. As a result, many former pirates settled in British Honduras and began cutting logwood, which was valuable for the production of textile dyes (Leslie 1997). The Spanish made periodic raids against British logging camps in Belize until 1798 AD, when British colonists and soldiers successfully defeated the Spanish in the Battle of St. George's Caye. This was the last time the Spanish attempted to exert political control over the territory of British Honduras.

The Maya no longer held control of northern British Honduras when the English loggers and colonists began to settle the country. They had retreated inland by this time, and the first mention of British contact with the Maya wasn't until the eighteenth century (Leslie 1997). At this time, British colonists made intrusions inland to extend the breadth of the lucrative logging industry. The Maya put up strong resistance to the intrusion of British colonists into their territory, and skirmishes between British and Maya forces are reported throughout the nineteenth century. Many Maya had entered northern Belize in the mid nineteenth century to escape Spanish retribution for the Caste War that erupted in the Yucatan Peninsula in 1847 (Reed 1964). Already incensed by their oppression at the hands of Spaniards, and not eager to lose their autonomy again, these Yucatec Maya did not hesitate to oppose the new threat. Maya forces, led by Marcos Canul, attacked a logging camp at Qualm Hill on the Rio Bravo south of Blue Creek in 1866, and defeated a detachment of British troops later that same year (Leslie 1997). Canul's forces went on to successfully capture Corozal Town in 1870. However, Canul was mortally wounded when his forces attacked the British army barracks at Orange Walk Town in 1872, and the Maya never again mounted a major attack against the British in Belize.

There is little mention of the inhabitants of northwestern Belize in the literature through the first few decades of the twentieth century. Thompson reported a small village at Blue Creek during his early exploration of La Milpa, undoubtedly populated

by Maya and Mestizo descendants of Yucatan's Caste War (Thompson, field notes quoted in Lichtenstein 2000). There are no remnants of this village visible today, and Wright (1959:197) mentioned only the presence of Belize Estate Company employees living in the region, along with small, seasonal groups of chicleros.

Mennonites began arriving in Belize from Manitoba, Canada and Chihuahua, Mexico in 1958 seeking religious freedom and agricultural land (Hinckley 1997). Blue Creek has one of the largest Mennonite communities in Belize today, which extends from the Guatemala border east to the Rio Bravo. Mennonite agricultural fields cover the Rio Bravo floodplain, yielding vast quantities of sorghum, corn, and rice. The upper escarpment plateau has been cleared of much of its vegetation for large cattle pastures, and the Dumbbell Bajo has largely been converted into rice fields and cattle pastures. Mennonite farming practices have proven highly destructive to archaeological ruins. Tractors are often used to level monumental architecture in an effort to create flat, manageable grasslands for pasturing cattle. Ancient architectural remains are also systematically removed and pulverized for road fill, a practice not limited to Mennonite settlements, but one that unfortunately is growing more common throughout Belize. Major sections of Colha, Nohmul, San Estevan, Kakabish, and Aventura have already been lost to provide raw material for northern Belize roads.

Geopolitics in Prehispanic Northwestern Belize

The Place of Northwestern Belize in the Maya Lowlands

Archaeologists have traditionally approached the subdivision of the Maya lowlands through methods that emphasized aggregate suites of stylistic traits among various material classes. Such methods are reminiscent of the Boasian emphasis on trait lists or the culture area approach championed by Kroeber. However, environmental attributes are an important consideration in determining actual socio-political divisions of the past. Topographic features and the distribution of natural resources certainly affected the movement of peoples and the spread of cultural attributes, and the corridors facilitating or inhibiting such movements should be more thoroughly explored.

Ralph Roys' (1957) work on the political geography of the Northern Lowlands included northwestern Belize only peripherally. He designated the Rio Bravo escarpment as the dividing line between Chol and Yucatec speakers. While such sub-cultural divisions were likely present on the landscape throughout Maya prehistory, and geological features such as escarpments, rivers, wetlands, and mountain ranges may well have defined the borders of these divisions, it is doubtful that Colonial period geopolitical relationships adequately reflect actual divisions of the Classic period. The dynamic socio-political processes characterizing the Terminal Classic – Postclassic transition surely redefined sub-cultural boundaries throughout the lowlands. However, material culture studies and epigraphy have made significant advances toward understanding sub-cultural affiliations in Maya prehistory. The northwestern Belize region above the Rio Bravo escarpment does appear to have been a distinct cultural border throughout the Formative and Classic periods (Guderjan 1996; Hammond 2001; Pollock 1965).

Culbert (1973:5, Fig. 1), and Rice and Culbert (1990:29, Map 1.1) placed northwestern Belize within an area that they label the Belize Zone, which conforms to the present national boundaries of the country of Belize, and is thus unlikely to reflect socio-political boundaries of the past (Figure 24). Pollock (1965:379, Fig. 1) compartmentalized the Maya lowlands in terms of principle architectural styles, and placed northwestern Belize in the Central Area, which encompasses western Belize, the Petén area of Guatemala, and southeastern Campeche and southwestern Quintana Roo, Mexico (Figure 25). The Rio Bravo escarpment marks the eastern boundary of the Central Area according to Pollock's map. Hammond and Ashmore (1981:21, Fig. 2.1) extended the boundary of the Central Zone further east than Pollock, basing their division of the lowlands primarily on stylistic features of Late Classic period architecture, sculpture, and ceramics, and secondarily, on environmental attributes. Each of the above culture-zone models represents an attempt to model spheres of influence in a meaningful fashion, based principally on artifact attributes, and each ostensibly focuses

on reconstructing the socio-political configuration of the Maya lowlands as it existed during the Late Classic period.

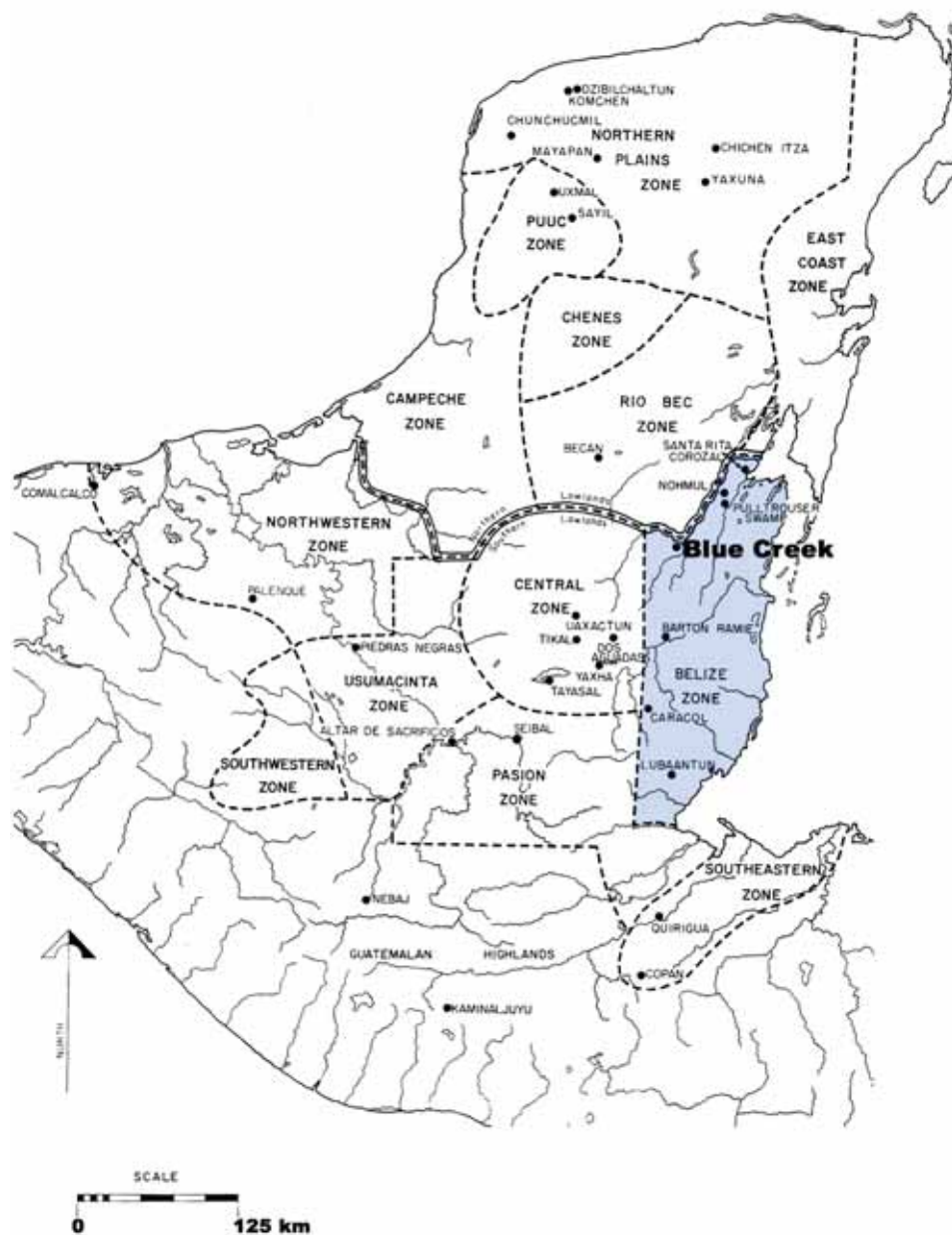


Figure 24: Zones of the Maya lowlands showing the placement of the Belize Zone and location of Blue Creek (adapted after Culbert 1973, Fig. 1).

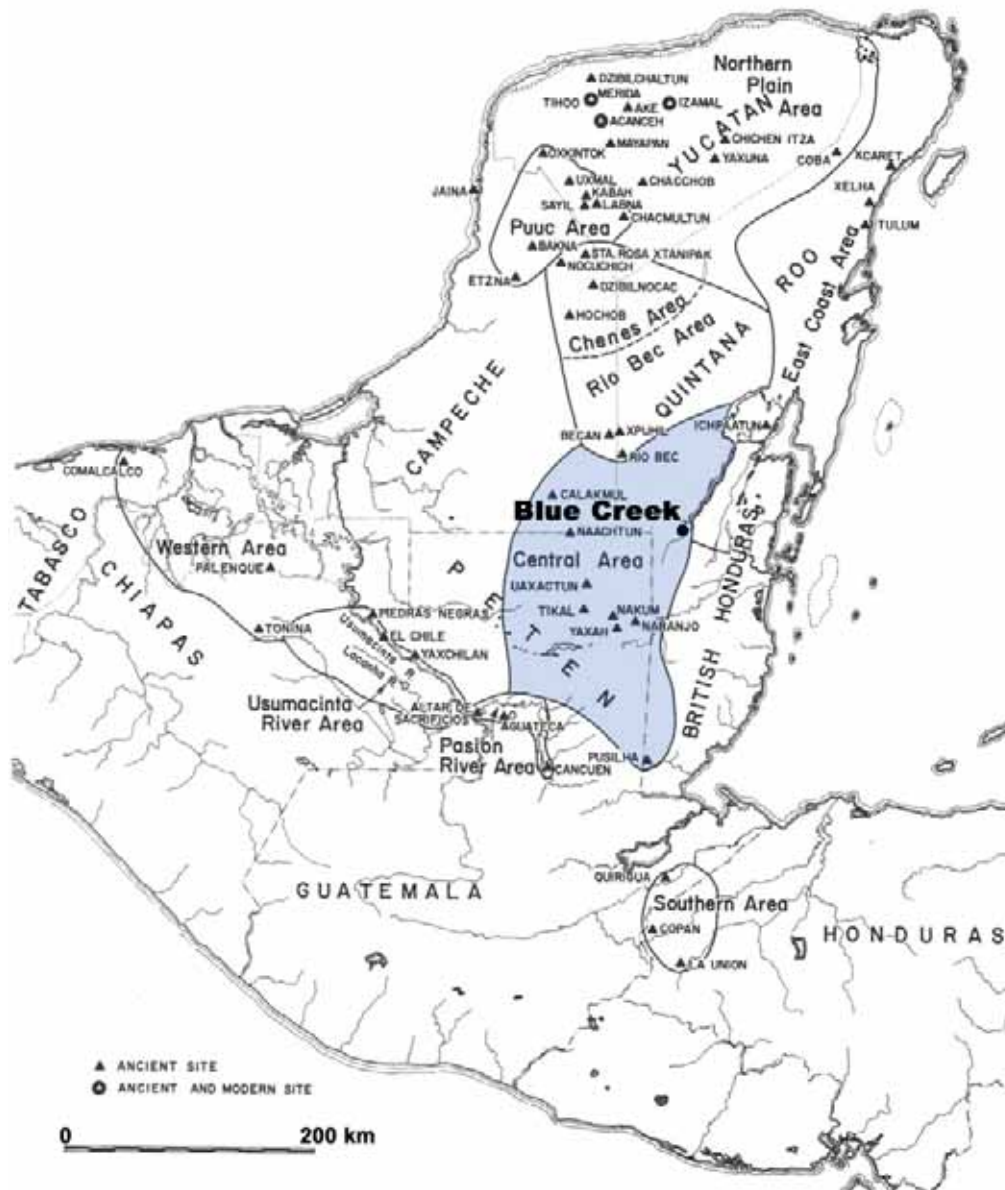


Figure 25: Architectural zones of the Maya lowlands showing the location of Blue Creek within the Central Area (adapted after Pollock 1965, Fig. 1).

In sum, architectural analysis has shown northwestern Belize to have been both strongly influenced by cultural traditions of the central Petén, and part of more pan-Maya traditions common across the lowlands. Significant variability exists among sites with regard to ceramic traditions, reflecting technological and artistic innovations occurring within local communities. However, the range of variability observed appears largely bound within formal macro-regional conventions, suggesting the presence of greater spheres of influence (Sullivan 2002). The Classic ceramic traditions of Northwestern Belize are well-aligned with those of the central Petén. Similarly, the processes and technology of stone tool manufacture, as well as the corpus of tool forms produced, is consistent with the patterns of material culture found in the central Petén, and dissimilar to those of northern Belize. This is not an argument for central Petén political hegemony. Rather, this suggests that adaptive technology and folk traditions developed a strong regional character during the Formative period, and these traditions endured as groups grew in size and spread out across the lowlands.

Super-polity Theory (Calakmul and Tikal)

The dynamics of regional interaction within the Maya lowlands are not fully understood. Material culture patterns within any region express both the dominance of internal socio-political stimuli and external macro-political influences, which waxed and waned over time, but were always present. Because much of the lowlands felt the influence of strong, hegemonic states during the Early and Late Classic periods, the degree to which these dominant states were able to control polities at the local level should be considered. The polities of Tikal and Calakmul sought to incorporate outlying sites into regional networks of alliances and tributary nodes, and experienced varying levels of success and failure (Figure 26; Martin and Grube 2000). These powerful and competing alliances reached their maximum influence at the end of the eighth century (Marcus 1976; Martin and Grube 1995). Coincidentally, warfare among these competing centers of influence also reached its pinnacle during the waning years of the Late Classic period.

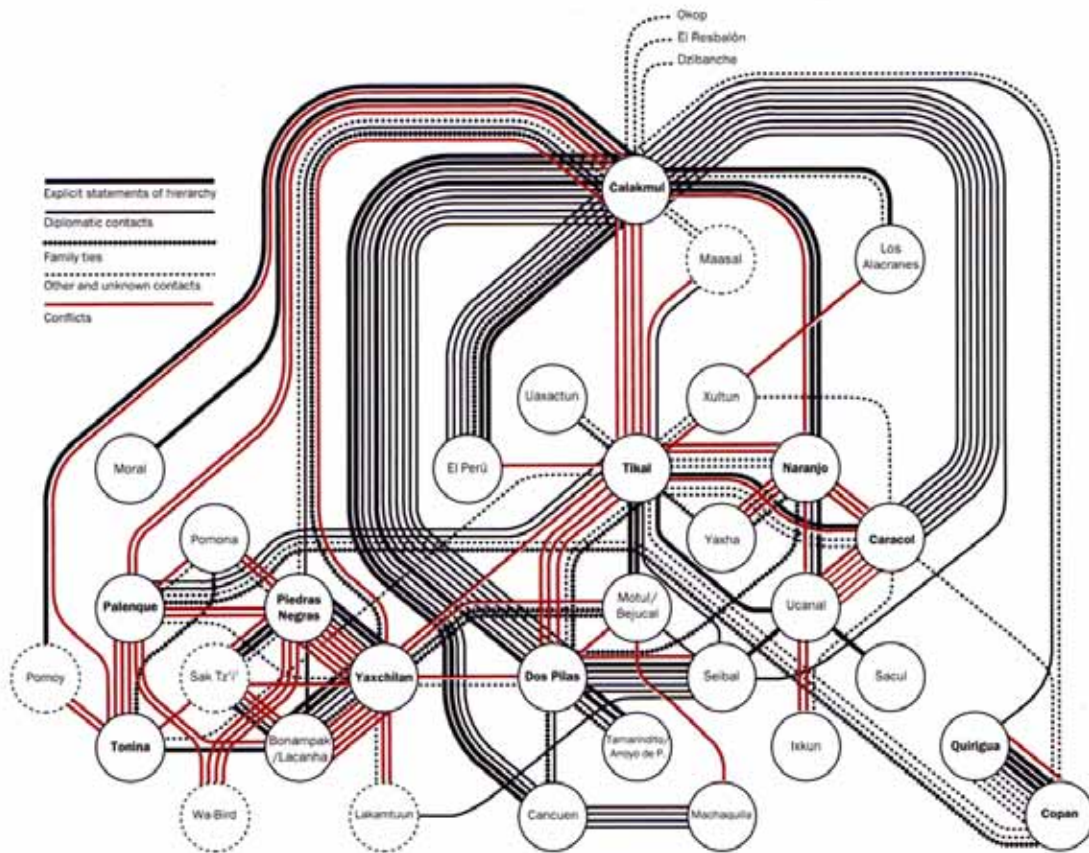


Figure 26: Regional alliance relationships of major lowland polities during the Classic period (from Martin and Grube 2000, *Chronicles of the Maya Kings and Queens*, Thames and Hudson publishers).

Tikal exerted influence over most of the central lowlands and beyond from the early fifth through mid sixth century, and lies approximately 100 km southwest of Blue Creek (see Figure 3). Calakmul became the dominant force in the lowlands in the mid sixth century, gaining dominance over much of the lowlands in an almost imperialistic fashion through the end of the seventh century, at which time Tikal again challenged for regional hegemony (Martin and Grube 2000). Calakmul is also approximately 100 km from Blue Creek, to its northwest (see Figure 3). From distance alone, it is not obvious

which of the two centers may have had greater influence over affairs transpiring within the Blue Creek polity, if indeed either had any influence. However, Rio Azul, was a strong ally of Tikal and lies only 40 km west of Blue Creek. This may have been close enough for Tikal to have made its presence felt in the Three Rivers Region. The construction of monumental architecture ceased at Rio Azul and began a protracted period of decadence coincident with Calakmul's defeat of Tikal in the mid sixth century. At Blue Creek, the "jade cache" was dedicated at Structure 4 at precisely at this point in time (Guderjan 1998).

There is currently little evidence at Blue Creek that would directly link its fortunes and history with either the Tikal or Calakmul regional states. In fact, it is not currently well understood what actual "control" either of these lowland super powers had over outlying sites, although it is supposed that tribute and military support were required of vassal polities (Martin and Grube 2000; Webster 2000). The strongest evidence for macro-political affiliation is often located on carved monuments and stelae. Apparently, while there was once a single carved stela at Blue Creek, it was looted from the site prior to the start of archaeological excavations in the area (Guderjan, Lichtenstein, et al. 2003; Neivens 1991). Any macro-political affiliations of the Blue Creek polity may have been predicated more in economic self-interest than in political hegemony. Still, it would be naive to exclude such relationships out of hand, particularly in light of the coincident sixth century declines at Tikal and Rio Azul, and the contemporaneous restructuring of the Blue Creek community. Such extra-regional machinations are best considered a contextual backdrop for events occurring locally at Blue Creek, however, not as a direct cause of such events.

Neighboring Sites in Northwestern Belize

According to Adams' (Adams 1984, Houk 1996:248) system, the rank ordering of sites in the Tree Rivers Region, in descending order of complexity, is as follows: Rio Azul, La Milpa, La Honradez, Kinal, Punta de Cacao, Chan Chich, Dos Hombres, Blue Creek, Gran Cacao, Ma'ax Na, Great Savanna, Quam Hill, and Chochkitam. Ixnoha can

be added to this list occupying approximately the same order of complexity as Blue Creek.

Adams method of computing comparative site complexity is based on the tabulation of components, weighing particular elements that represent more significant resource investments or, presumably, more significant displays of opulence. Adams' formula adds the number of courtyards at a site to the number of acropolises (x2), an acropolis defined as a compact cluster of structures occupying a shared platform. Others have augmented this system by factoring a volumetric assessment of structures (Turner, Turner, and Adams 1982). Both methods assume that the scale of public/ceremonial architecture directly relates to the scale and centrality of political power. In premise then these measures evaluate site size, political authority, and relative economic status.

Guderjan further augmented Adams' method of computing site complexity by factoring in the number of plazas, stelae, ball courts, and large buildings (1991). Guderjan stipulates that plazas, to be defined as such, must include at least one temple and have a formal entrance (1991: 104). Guderjan incorporates stelae and ballcourts as they are regarded as markers of political authority. For this same reason he incorporates a valuation of "large buildings", which he defines as structures greater than 10 meters in height (1991:104). The Guderjan formula reads as follows:

$$(\#courtyards) + 2(\#acropolises) + (\#stelae) + (\#ballcourts) + .5(\#buildings \text{ height over } 10m) + 2(plazas)$$

Each of the methods reviewed have inherent disadvantages in attempting to determine power relationships in prehistory, and these may be broadly defined as being methodological or theoretical in nature. Methodological complications involve the thoroughness with which the actual extent of sites is understood when comparative analysis of their respective complexities is undertaken. First, measures of site complexity often only take the site core into consideration (cf. Houk 1996). Extensive hinterland surveys at many sites have shown a much more dynamic articulation of structural elements, with multiple nodes of ostensibly 'elite' architecture located away from the site core (Barnhart 2001; Chase and Chase 2001). Also, the assessment of

complexity strictly through survey fails to account for temporal differences in site aggregation. As Maya architecture most often reflects multiple phases of construction over long periods of time, it is important to understand the temporal sequence of construction events at any one site in order to understand its relative complexity and to compare the ability of its elites to control labor at any one point in time. With regard to Guderjan's formula, the number of stelae present at a site often has little to do with the number that may have been historically erected at the site, as prehistoric destruction and historic looting have removed many monuments. Theoretical issues exist apart and in conjunction with methodological issues. It has been argued that the dispersal of elites away from the central precinct of sites signifies a weaker political structure (Fash 1991; Fash and Stuart 1991; Webster 1989). If accurate, the number of plazas at a site would not be a reliable marker of elite political power. Addressing dynamic issues such as regional hegemony without the ability to consult complementary analyses from the majority of sites in the region promises little certainty and offers an inadequate level of objective, quantifiable evidence.

Blue Creek Size and Complexity in Regional Comparison

Regardless of the computation method used, Blue Creek was a site of modest size that was overshadowed by other sites in the region, even during its Early Classic period apogee. However, its location at the terminus of the circum-Caribbean trade network, and possible function as a point of transshipment, proved advantageous, affording its inhabitants greater opulence than the site's size and complexity would suggest possible. Jade is commonly located in commoner contexts at Blue Creek, though not with the frequency in which it is found in elite contexts.

There is no unequivocal evidence to suggest that Blue Creek operated under the hegemonic control of another site at any point in its history. On the contrary, the site seems to have directly benefited from its function as a trade terminus. However, an analysis of lithic materials at the site, combined with a survey of material outcrops throughout the MRP permit area, suggests that Blue Creek procured stone tools through

participation in a regional exchange network as early as the Middle Preclassic period. This point will be elaborated upon in the chapters that follow. The major issue is that Blue Creek appears to have never been wholly self-sufficient. The site's deficiency in critical material resources required its perpetual integration within, minimally, regional exchange networks that would surely have involved a high level of elite interaction, and undermined isolationism, whether or not desired.

Guderjan has suggested that the restructuring of the Blue Creek community observed during the Late Classic period may relate to the larger political history of northwestern Belize, with La Milpa emerging as the dominant hegemonic force in the region (Guderjan 1996). Such regional domination is a geopolitical process entailing the manipulation of power relationships between and within formerly independent sites. It is thus appropriate to consider the possibility that resource distribution and consumption patterns at Blue Creek during the Late Classic Period reflect the influence of an emergent, regional political economy. However, the impetus for changing settlement patterns and labor investments may simply relate to the major increase in population observed during the period. Whether primarily political or economic, it is important to consider both internal and external motivations for the restructuring of the Blue Creek community during the Late Classic.

Summary

The Place of Blue Creek in the Archaeology of Northwestern Belize and the Maya Lowlands

Blue Creek is one of the most intensively excavated sites in northwestern Belize. As such, it offers a rare glimpse into the temporal and spatial dynamics of ancient Maya settlement and community structure for an area of the lowlands that has only recently received archaeological attention. Rather than being structurally redundant with regard to other sites in the region, the site exhibits a unique pattern of social, political, and economic relationships due to environmental influences and circumstances of its location at the edge of the Rio Bravo escarpment.

The geology of the landscape on which the polity of Blue Creek was established is poor in outcrops yielding lithic raw material that could be knapped into stone tools. Productive lithic resource nodes are in finite distribution across the settlement zone, presenting a valuable opportunity to study differential patterns of exploitation throughout the community. While many Maya sites in northwestern Belize were self-sufficient with regard to lithic resource procurement, being located in proximity to large *bajos* offering abundant quantities of such material, Blue Creek depended on importing stone tools from outlying source areas. At the same time, an extensive network of channelized fields is located in the deep, rich soils below the escarpment at Blue Creek, suggesting that the site itself may have been involved with resource provisioning. While Blue Creek depended on imports, other sites may have been dependent upon its exports.

Blue Creek's location at the terminus of an extensive trade route that redistributed commodities to market outlets from the Motagua River Valley, along the Caribbean coast of Guatemala, Belize, and the Yucatan Peninsula, and down the many river arteries of Belize afforded the site trade advantages observed in few other areas of the Maya lowlands. Judging by the volume of jadeite artifacts recovered from the site, Blue Creek must have been a relatively wealthy community, particularly for its modest size. Its fortunes seem to have altered significantly during the sixth century, however, as the volume of imports commodities consumed by the community sharply declines, and jade ceases to flow into the community almost entirely. This occurrence suggests that long-distance trade patterns may have been fundamentally altered in the Late Classic, causing sites to adapt to new social and economic realities.

The motivation for Blue Creek's Late Classic period restructuring remain poorly understood. Influences for the restructuring may have been predicated in the alteration of local, regional, or macro-regional socio-political relationships. Whether Blue Creek can be best understood at any point in time as an autonomous political entity, or whether it was subsumed within a larger hegemonic sphere of influence, remains to be adequately substantiated. What can be said with certainty is that Blue Creek remained dependent on external source areas for critical economic commodities throughout its

settlement history, and was thus not likely to have ever been politically or economically isolated. The increasing regionalism and decreasing reliance on exotic commodities observed at the site during the Late Classic period is hardly a unique phenomenon, but rather one observed across much of the lowlands.

This work explores the important middle ground between the unique adaptive institutions expressed at Blue Creek, and those features and processes that broadly reflected Maya culture in general. Without separating the particulars from the generalities, there can be little certainty that material culture patterns at Blue Creek have anything meaningful to offer researchers at other sites in the Maya lowlands. Toward this end incorporating fine-grained landscape data into archaeological analysis and interpretation is of vital importance. Blue Creek cannot be understood without a detailed appreciation for the structural components of its environmental setting. The mosaic landscape of the Rio Bravo escarpment created both capabilities and limitations for Blue Creek's inhabitants, and it is with this realization that intra- and inter-community relationships are examined in the chapters that follow.

CHAPTER IV

AN OVERVIEW OF LITHIC RESEARCH IN THE MAYA LOWLANDS

This chapter presents an historic overview of lithic research in the Maya lowlands focusing on the use of chert resources coincident with the general theme of this work. While obsidian cores and blades, greenstone and jadeite celts, and groundstone tools are included in this overview, they are not addressed in any great detail. Readers are encouraged to consult alternative sources that deal directly with these fields of lowland Maya lithic research for a more thorough treatment of the research conducted on each of these topics.

Early Lithic Research in the Maya Lowlands

Rovner et al. (1997:5) have defined three major periods in Maya lithic analysis. The authors demarcate Kidder's investigations at Uaxactun as the first major turning point in the analysis of lowland lithic assemblages, and works produced prior to it comprise those of the first period. Prior to Kidder (1947), stone tools were regarded as ancillary discoveries of little value and were seldom included within the main text in archaeological reports, instead being relegated to the report appendices. Figure captions often provided the only description of artifacts during this early period of Maya research. Tools were classified using broad functional terminology based on their general form with little regard for their archaeological context or technological attributes. No use-wear studies were conducted to tests functional assertions.

Archaeological site reports and other manuscripts produced during the late nineteenth and early twentieth century, largely prior to the Carnegie Institute of Washington excavations at Uaxactun, reflect the biases governing Mesoamerican research during that period in their exclusive attention to architectural form and style, settlement (within central monumental zone of sites), monumental sculpture, and objects d'art (e.g. Maler 1908-1910; Maudslay 1889-1902; Morley 1937-38; Totten 1926; Tozzer 1911). One of the major foci in Maya archaeology at this time was recording

dates found on monuments, stelae, murals, lintels, and architectural facades. Other artifacts, including stone tools, were only infrequently mentioned in these early works, and substantive analysis was wholly absent. Ceramic vessels received the greatest attention, often being described and illustrated in report appendices.

A small number of works from this early period of Maya lithic analysis made a nominally more substantial effort in describing artifacts. At San Jose, Belize, for example, Thompson and Shepard (1939:169-170) noted the metric attributes of various stone tools and provided size ranges for individual artifact types. The primary concern within their analysis of the artifacts at San Jose was for distinguishing types by morphology and general material preferences, as well as assigning chronological information based on ceramic and long-count correlations. Their piece-by-piece comparison of flaking and metric attributes is revealing in that it suggests a very low incidence of artifact recovery, indicative of the excavation strategies employed during this early period of Maya research. The analysis also fails to appreciate the nature of attribute variability expressed by various classes of tool, and he does not convey awareness for the relationship this variability has to functional considerations, material constraints, production processes, or spatial and temporal patterns of consumption. Thompson and Shapard should not be singled out for the limitations of their work. Indeed, their practices were superior to many of their generation. The work of Thompson and Shapard at San Jose merely exemplifies the limited attention scholars gave to the analysis of utilitarian stone tools during the early period of Maya lithic research.

The Formative Phase of Maya Lithic Research

The second major period of lithic analysis in the Maya lowlands, as defined by Rovner and Lewenstein (1997:5), is that following the work of Kidder at Uaxactun and continuing through the mid 1970s. I refer to this as the Formative period of Maya lithic research as the archaeological investigations conducted during at this period formulated the theoretical models that led to more rigorous investigation of all classes of artifact,

and which ultimately continue to influence Maya scholarship today. This period was substantially comprised of research conducted under the auspices of the Peabody Museum of Archaeology and Ethnology at Harvard University (Hammond 1975; Willey et al. 1965; Willey 1972, 1978; Tozzer 1957), the Carnegie Institute of Washington DC (Kidder 1947; Pollock 1962; Smith 1950; Smith and Kidder 1951), and the University of Pennsylvania (Coe 1959; Shook 1958).

The origins of lithic research's formative period date to the 1930's and 1940's, at which time the Maya lowlands were subjected to more extensive and broader-based archaeological investigations. Although the recording and analysis of architecture, monumental sculpture, and hieroglyphic dates still formed the core of such studies, excavation programs were expanded and more attention was given to the recovery and description of artifacts. Studies by Ricketson and Ricketson (1937) and Kidder (1947) of artifacts recovered in excavations at Uaxactun characterize this period. The analysis of stone tools within these works is essentially limited to the development of artifact types and the cursory description of variability found within each of these types. However, Kidder's work is particularly notable for his attempt to compare forms and variants found at Uaxactun with other lowland sites.

Kidder's (1947) study at Uaxactun is among the first works in Central American archaeology to specifically devote a volume to the analysis of artifacts, and not merely incorporate cursory descriptions within the appendices of a site report (Hester 1976:12). Kidder's analysis benefited from his earlier work in the American southwest where a relative lack of complex architecture and sculpture helped to keep the analysis of stone tools in the foreground of research endeavors.

At Uaxactun, Kidder attempted to distinguish stone tool sub-forms based on metric trends, and macroscopically addresses the presence and distribution of use-wear. Lacking evidence from experimental replication, Kidder offered tentative functional classes based on the morphometric capabilities and limitations of various tool forms. Kidder, to the extent possible, also attempted to provide a cursory distribution of various

tool forms appearing in archaeological deposits throughout the lowlands, while he also suggested that stylistic trends varied through time.

Stone tools eventually began to emerge from the appendices of excavation reports with the publication of artifact-driven volumes during this period of lithic research. Considerable attention was given to the description and illustration of stone tools in the milestone works detailing excavations and archaeological discoveries at Piedras Negras (Coe 1959), Mayapan (Proskouriakoff 1962), Barton Ramie (Willey et al., 1965), Altar de Sacrificios (Willey 1972), and Seibal (Willey 1978). Greater attention was also given to providing a description of the context tools were recovered within, though contextual comparisons were often limited to distinguishing between ritual and non-ritual deposits. Stone tool analyses included within these works offered little more than a qualitative assessments of use based on macroscopically observable wear and polish, descriptions of morphologic variability within tool classes, and noting the temporal variability exhibited by various recognized tool types.

Although more attention was certainly given to the analysis of tool forms during the formative period of lithic research, analytical procedures remained rather primitive and inconsistent. Experimental studies in use-wear were absent in the Maya area and high-power microscopy had not yet become a widespread technique in the analysis of stone tools. Functional assessments of tool types generally relied on a balance of context and conjecture. Much of the variability observed within and between these works, with regard to artifact taxonomy, is now better understood through the influence of lithic reduction sequences and artifact use-life. For example, in excavations at Barton Ramie, Baking Pot, and Altar de Sacrificios, Willey and others (1965, 1972: 170) distinguished between several different sub-classes of laurel leaf biface through separating them into three size categories and defining them as either ceremonial (laurel leaf blades) or utilitarian (bipointed knives). In describing laurel leaf bifaces recovered in excavations at Seibal, Willey (1978) claimed that there were no apparent criteria for distinguishing between size-defined sub-forms as they appeared to occur along a size continuum from small to large without discrete size classes. However, Willey (1978:112) continued to

distinguish between utilitarian and ceremonial forms stating that the differences separating ceremonial “laurel leafs” and utilitarian “bipointed knives” rested in the finer flaking and absence of use-wear on those found in ceremonial contexts, and the presence of use-wear and tendency toward exhibiting a greater thickness to length ratio on utilitarian specimens. Regardless of whether the form co-occurs in both utilitarian and ceremonial contexts, which it certainly does, conceptually distinguishing between two separate tool types based on whether or not the tool was used or how finely it was crafted offers the analyst few advantages.

Many of these formative works employ inconsistent terminology in describing specific tool types. For example, the celtiform biface is nearly ubiquitous in Late Preclassic period through Postclassic lowland Maya artifact assemblages. Yet, for all its abundance, it is seldom referred to using consistent terminology. Celtiform bifaces have been referred to in site reports as *oval bifaces* (Hester and Shafer 1991: 156), *choppers* (Coe 1959: fig.1), *chopping tools* (Kidder 1947: fig.61, c-k), *standard choppers* (Willey et al., 1965: 426), *general utility bifaces* (Aldenderfer et al. 1989:53), *cordiforms* (Rovener and Lowenstein 1997: fig.8), and *oval biface celts* (Hester, et al. 1991: 69). Within this work the term “*celtiform biface*” is used to avoid confusion with the *large oval biface* produced in Colha workshops during the Late Preclassic and Early Classic periods. In another example, Late Classic *general utility bifaces* (Hester 1982a: 48) have been variously referred to as *turtle-back axes* (Ricketson and Ricketson 1937: plate 56, a-2), *truncated-base biface celts* (Shafer and Hester 1983: fig.8, e), and *choppers* or *general utility tools* (Willey et al., 1965: fig.273, f).

Consistency in taxonomic description is increasing in the field, but there is still much room for growth in this arena. The first obstacle in overcoming the terminological chaos of the present is to get scholars to agree on a standardized artifact typology, but this is complicated by the fact that there is little agreement as to what artifact attributes should be used in formulating tool types. Terminology based on generalized form (ex. stemmed blade, celtiform biface) rather than speculated function (ex. projectile point,

chopper) should be given priority to avoid tethering tool types to unfounded assertions of their employment.

Stone tools were no longer wholly ignored by Maya scholars following the work of Kidder at Uaxactun, though they were nonetheless mired in analytical purgatory and excluded from consideration in theory building (excluding obsidian). The analysis of ceramics, however, flourished throughout this period. Inspired by the success of ceramic seriation in the Old World, New World archaeologists devoted much time and effort toward the development of ceramic chronologies (e.g. Brainerd 1958; Gifford 1976; Smith 1955, 1971).

A Period of Enlightenment in Maya Lithic Research

The Early Contributions

Rovner and Lewenstein (1997:5) begin the final period in Maya lithic research with the production of Rovner's dissertation in 1975. This is perhaps a bit self-aggrandizing, but the mid 1970s were a critical time for change in the nature of lithic research in the Maya area. The volume of material recovered from the major excavation programs of the 1960's and 1970's, as well as a significant paradigm shift in the field of archaeology (Sabloff 1990), provided a platform for the more substantial analytical works produced during the late 1970's. Due to the wholesale methodological and theoretical changes affecting Maya research in general, and lithic research specifically, at this time, I believe this time period can be accurately described as one of enlightenment. The most significant contributions made during the early enlightenment period include those of Sheets (1975), Rovner (1975), and Hester and Hammond (1976). Significant later contributions include those of Aoyama (1999), Clark (1988), Hester and Shafer (1991), and Lewenstein (1987).

Sheets (1975) evaluated the theoretical models and analytical methods used for developing artifact classification systems, advocating a technologically-based model that is independent of functional classification in studying lithic industries. Sheets (1975:372) defined an *industry* as "a manufacturing or productive enterprise focusing on

a raw material and involving certain common means of processing that material.” This definition recognizes that the structure of production systems is predicated on the dual influence of environmental variables and culturally transmitted technological and ideational paradigms. Although his analysis was based on the study of a Highland obsidian industry, its value transcends this context through its ubiquitous utility. The technologically-based behavioral analysis proposed by Sheets articulated a method of analysis with the potential for objectively explaining much of the formal variability observed in all manner of stone tool assemblages. In so doing it provided a superior system of artifact classification that effectively ended the use of the functionally-based proclamatory typologies that were employed during the previous decades of Maya lowland lithic research.

Erwin Rovner's dissertation (1975) provided a detailed study of the stone tools recovered in excavation at Dzibilchaltun, Becan, and Chicanna as a part of the larger research program undertaken by the Middle American Research Institute at Tulane University. Rovner's study synthesized the spatial and temporal distribution of tool types recovered in the northern lowlands with similar data gleaned from other sites throughout the lowlands in an attempt to develop a historic sequence of stone tool use for the general Maya area. Rovner's (1976:45-46) attempt at integrating artifact data into larger historical processes occurring in southern Mesoamerica through trying to distinguish between local and foreign materials and technology was commendable. This effort is ultimately undermined by his over-emphasis on external mechanisms of change and failure to adequately consider internal mechanisms. Regardless of its shortcomings, Rovner's effort is commendable in that it attempts a synthesis of archaeological data (though comparatively little was available at the time) in applying artifact data to larger social issues. His effort is clearly more directed at history than process, but each of these objectives informs and supports the other, and their combination makes the science of archaeology more holistic.

A great deal of information has been garnered since Rovner's work relating to lowland and highland interaction spheres (Culbert 1990; Marcus 1993; Martin and

Grube 2000; Miller 1983), production and consumption patterns (Aoyama 1999; Clark 1988; Dockall and Shafer 1993; Hester and Shafer 1991; McAnany 1989b), lithic craft specialization (Michaels 1987; Roemer 1984; Shafer 1982a), and recycling processes (Shafer 1983). Much of this new information has come directly through or been influenced in some way by the investigations of the Corozal Project. The Corozal Project was initiated in 1973 by the British Museum and Cambridge University, and surveys conducted under its auspices located and assessed many sites in northern Belize, including the site of Colha. At Colha, investigators discovered stone tool workshops of unprecedented grandeur.

Colha

Norman Hammond, principal investigator of the Corozal Project, and Thomas Hester, of The University of Texas at Austin, organized the 1976 Belize Field Symposium in Orange Walk Town, Belize to evaluate the state of Maya lithic studies. This inaugural Maya lithics conference (Hester and Hammond 1976) produced a collection of contributed studies inspired by the Corozal Project's discovery of Colha, Belize. Each of the authors recognized the paucity of quality lithic analysis in the Maya lowlands, with Hester in particular noting its deficiencies in comparison to the work being done generally in North America (Hester 1976:11). Payson Sheets (1976) delivered a summary of lowland Maya lithic research that offered more of an inventory of completed analyses than a critical review. Hester (1976) offered a more critical review of functional analysis that pointed out the almost total neglect of flake analysis (1976:15-16). Other works from the symposium focused on obsidian trade (Hammond 1976; Johnson 1976) and craft technology (Rovner 1976; Shafer 1976). As researchers attending the symposium addressed the progress of lithic analysis in the Maya area, their discontent with the state of the field served to inspire a testing program centered on the site of Colha and the northern Belize chert-bearing zone.

Testing programs based at Colha and other sites within its environs revealed the presence of large-scale stone tool production and craft specialization among the northern Belize Maya initiating in the Late Preclassic period and continuing through the Middle

Postclassic period (Hester 1985; Shafer 1982a). The massive deposits of production waste found in both specialized production localities and adjacent to domestic space preserved a stratified material record of production patterns over time. Debitage deposits at Colha have provided a detailed record of manufacturing technology (Shafer 1985), relative production volume (Shafer and Oglesby 1980), synchronic and diachronic variation in formal tool production patterns (Hester 1985; Gibson 1986; Shafer 1985), variability and range of deviation for specific tool forms along their design trajectory (Roemer 1984; Michaels 1987), standardization of design execution (Barrett 1999; Michaels 1987; Roemer 1984; Shafer 1985), and raw material selection (Michaels and Shafer 1994).

Studies in northern Belize have also been instrumental in proving the applicability of fine-grained lithic analysis in the development of broad theoretical models of lowland Maya prehistory. For example, an occupational hiatus occurred at Colha beginning in the eighth century and continuing for approximately a century (cf. Valdez 1994). Lithic production technology and tool morphology are in sharp contrast on either side of this hiatus, strongly suggesting that a change in social-cultural affiliation occurred between these periods (Barrett and Scherer 2002). This assessment is further supported through ceramic, settlement, and architectural analysis (Shafer and Hester 1996). Interestingly, a focused redirection of production patterns is reflected in lithic assemblages dating to the Terminal Classic period at Colha. A substantial number of workshops began producing large quantities of stemmed blades at this time to the virtual exclusion of other tool types (Barrett and Scherer 2002; Masson 1989). This suggests a possible period of hostility affecting northern Belize that is temporally coincident with the collapse of many Petén sites. The Terminal Classic period culminates with the violent termination of Classic period settlement at Colha, including the execution of at least 55 individuals (Barrett and Scherer 2002; Massey 1989; Massey and Steele 1997; Mock 1994a). This example highlights the value of lithic analysis for understanding the complex social and historical processes that affected the Maya lowlands.

Investigations at Colha and other sites within the northern Belize exchange network have proven instrumental in quantitatively assessing tool use, thus objectifying what had until then been primarily a speculative endeavor. Indeed, advances in the field of lowland Maya lithic analysis were so radical following the work of the Colha Project that a second conference focusing on stone tool use by the Maya was deemed necessary. The papers from the Second Maya Lithic Conference, edited by Hester and Shafer (Hester and Shafer 1991), addressed issues of artifact taxonomy (Potter 1991), site-specific patterns of production, consumption, and trade (Clark and Bryant 1991; Fedick 1991; Mitchum 1991; Potter 1991; Shafer 1991; Thompson 1991), production technology (Hester, et al. 1991; Shafer 1991), and tool function (Eaton 1991; Gibson 1991; Lewenstein 1991a, 1991b).

Eaton (1991) offered a promising line of analysis in considering the relationship between the forms and functions of various tool types in conjunction with the resource needs of other industries (i.e. architecture). Eaton's work is only weakened by its reliance on theoretical, if practical, models rather than empirical evidence garnered from artifact replication and experimentation. His inferences regarding the resource needs of commoner residences to elite residences, for example, would be strengthened by the inclusion of an actual data set supporting his suppositions (e.g. Abrams 1994).

Lewenstein offered two works firmly based in empirical data. Lewenstein experimented with replicated tools in testing the relationship between tool function and edge angle, and also recorded the wear patterns left on chert tools as the result of various wood working tasks. With regard to edge angles, Lewenstein (1991a:215) found that "there are some definite differences in edge angles between tools used for different functions ... [but] there is sufficient overlap in the ranges between most groups to warrant caution against using just this attribute to infer function, even when tool morphology is considered."

Together, the papers of the second Maya lithic conference present an array of progressive studies aimed at expanding current knowledge of specified lithic industries and manufacturing traditions. These studies represent an investigative benchmark that

should be reached and expanded upon for all time periods and regions throughout the Maya area.

Technological vs. Contextual Approaches

Braswell (2001) has stated that lithic analyses in the Maya area can be categorized into two broad methodological approaches, to which he attaches the labels bottom-up approaches and top-down approaches. Using this template Braswell defines bottom-up approaches as those predicated on the analysis of production technology. These typically employ microscopic and macroscopic use-wear analysis, replication experiments, and experimental use studies. Bottom-up approaches are typically data-rich works using metric and morphologic variation and use-wear patterning to define artifact typologies, generally highlighting spatial and temporal changes in such patterns (cf. Clark 1988; Rovener et al. 1997). Bottom-up approaches as thus best defined as technological approaches to lithic analysis. Top-down approaches are defined as those that are more concerned with the utility of stone tools as markers of economic specialization at the household or community level (particularly with regard to specialized production and subsistence pursuits), and are thus essentially contextual approaches. Top-down approaches use lithic data to provide evidence for the integration of regional economies, as a means to better understand larger systems of long-distance commodity exchange, and as an index of the relative social status of individuals and groups (cf. Braswell 2001; Lewis 1995). Top-down approaches are broad theoretical works that do not focus to any significant degree on site-specific patterns in production technology and resource consumption. Instead, they deal more specifically with tools as commodities that are able to distinguish between the relative abundance or scarcity of resources across landscapes and regions, differences in social status among consumers, the character of political relationships existing between various sites, and whose presence or absence within particular site contexts is used as a culturally relevant marker of differences in access to economic resources (Aldenderfer, et al. 1989; Lewis 1995; Santone 1997).

The utility of both technological and contextual approaches is supported by their ability to elucidate diachronic and synchronic patterns of behavior. The approaches produce complimentary data sets. While these data offer only a fragmentary view of behavioral systems in isolation, they provide a dynamic view of such systems when considered together. However, the “top-down” – “bottom-up” dichotomy is a useful medium for presenting recent progress in lowland Maya lithic analysis. Technological and contextual contributions to the study of material procurement, manufacturing technology, tool function, and behavioral processes are examined below.

Technological Approaches (Bottom-up) – Questions and Methods

Procurement

Chemical characterization studies form the bulk of bottom-up approaches to lithic resource procurement. The initial chemical characterization studies in the Maya area were performed by Heizer (Heizer, et al. 1965) and Stross (Stross, et al. 1968). These studies proved the validity of using chemical characterization techniques in making distinctions between different obsidian outcrops, though each was based on a limited sample size. Subsequent studies have contributed greater resolution to the variability in Mesoamerican obsidian sources, enabling researchers to distinguish between source areas more precisely.

Sidrys and Kimberlin (Sidrys 1979) were among the first to employ chemical characterization in studying a Maya lithic assemblage. Sidrys and Kimberlin used instrumental neutron activation analysis (INAA) on obsidian tools from El Bálamo, Guatemala. Their study successfully illustrated a switch in procurement source-area occurring near the end of the Late Preclassic period. Based on the findings of Stross et al. (1968), Hammond (1972) proposed one of the first synchronic models for Maya obsidian trade, theorizing that El Chayal obsidian traveled along inland river and trail routes while Ixtepeque obsidian traveled within a circum-Caribbean trade network. Subsequent studies have found numerous exceptions to expected distributions based on this premise (Healy, et al. 1984).

In general, there seems to be greater predictability in the temporal distribution of obsidian from various sources than there is spatial distribution at any point in time (Dreiss and Brown 1989). Nelson (1985) has extensively examined temporal patterning in obsidian distribution, finding that San Martin Jilotepeque obsidian dominated lowland consumer contexts during the Middle Preclassic. Nelson also found that San Martin Jilotepeque remained the dominant obsidian source throughout much of the southern lowlands during the Late Preclassic, but that El Chayal increased in commonality, eventually eclipsing SMJ obsidian in areas like Palenque. Obsidian recovered in Early Classic contexts is almost exclusively from the El Chayal source, though Ixtepeque obsidian is found in trace amounts in northern Belize and southern Quintana Roo (Nelson 1985). El Chayal continued to be the dominate source of lowland obsidian in Late Classic, but its dominance steadily decreased until it was eventually replaced by Ixtepeque obsidian in the Terminal Classic period at sites in Belize and Quintana Roo, Mexico. El Chayal obsidian remained dominant at sites in inland Petén, Guatemala and Yucatan, Mexico in the Late and Terminal Classic periods (Fowler 1991). Most data from Postclassic coastal sites attests to the dominance of Ixtepeque obsidian during that period, though some temporal variability existed (Nelson 1985). Mexican obsidian sources, while never dominant, were more widely used during the Early and Middle Postclassic, while Late Postclassic contexts yield Ixtepeque obsidian almost exclusively (Dreiss 1988).

Chemical characterization studies have been far more successful in distinguishing between obsidian source areas than they have chert sources. Sourcing studies performed within the northern Belize chert-bearing zone have shown only a limited and equivocal ability to make accurate distinctions between outcrops (Tobey 1985; Tobey, et al. 1994). The homogeneity of chert resources in northern Belize has proven to be an obstacle to sourcing analysis in that region. Chemical characterization studies have been successful in distinguishing between northern Belize cherts and material resources outside that region (Cackler, et al. 1999), though this is generally accomplished with accuracy through visual sourcing.

One of the major complicating factors in sourcing chert is the heterogeneity that characterizes most outcrops. The range of variability observed through chemical characterization analysis within any one outcrop often overlaps the variability of other outcrops. The accuracy of identifying chert outcrops could be substantially enhanced through fine-grained research performed at the landscape level of analysis. Chert outcrops may be characterized and compared by grain size, color, banding, microfossils, impurities and inclusions, and cobble form. Sourcing by visual identification requires a comprehensive material type collection from geographically diverse resource nodes, but it may be the most precise method available for identifying non-obsidian lithic resources.

Technology

Bottom-up approaches have been perhaps most prolific in the study of manufacturing technology. Considerable advances have been made in technological analyses through the use of linear reduction models (Fowler 1991:2). Holmes (1919) implicitly advocated the use of linear reduction models in lithic analyses early on, though such models would not come into popular use for many decades. Sheets (1975) essentially used a lithic reduction model in his behavioral analysis of Highland obsidian industries, though he did not refer to it as such. Linear reduction models produce inherent classifications that illustrate the behavior of the craftsman, the production technology of the culture, and the constraints realized by raw material variability. Due to the dynamic interaction of natural and cultural forces, which varied across landscapes and regions and over time, the organization and technology of production must be studied and understood both on the level of sites and on the order of regions (after Sheets 1975; Fowler 1991:3).

Significant contributions in the study of technological systems and production organization have come from research in northern Belize, and at the site of Colha in particular. Several researchers have described the technology of lithic production employed at Colha during various periods in lowland history (Drollinger 1989; Hester 1985; Masson 1989, 1993; Michaels 1987, 1994; Roemer 1991; Shafer 1985, 1991;

Shafer and Hester 1983). Diachronic analyses of stone tool production at Colha, aided by the use of linear reduction models, have shown a disjuncture in the modes and methods of tool manufacture at the site between the Classic and Postclassic periods (Barrett 1999; Michaels and Shafer 1994; Shafer 1985). Barrett and Scherer (2002) have suggested that this disjuncture is indicative of a population replacement at the site. Technological approaches in lithic analysis have been instrumental in identifying the fine detail of production systems, such as determining production volume. Shafer and Oglesby (1980) have shown the feasibility of flake-to-tool ratios in measuring the production volume of trenchet-bit tools, but find no easy method for determining production volume for tool forms lacking diagnostic terminal flakes.

Hayden (1987a) has offered a remarkable ethnoarchaeological and ethnographic study of stone tool production among modern highland Maya in Guatemala. While groundstone manufacture is the dominant focus of these Highland studies (Hayden 1987c; Nelson 1987a, 1987b), Hayden's study of household tasks, tool use-life, and patterns of tool replacement is insightful for all systems of stone tool manufacture and studies of resource consumption (Hayden 1987b). Hayden found that the continued use of old-technology tool forms does not necessarily fall off with the introduction of new forms when analyzed at the household level, and that disposal patterns have a greater effect on the visibility of tools used in the domestic sphere than does curation. This study fits the definition of a bottom-up approach to lithic research in that it makes inferences regarding larger social processes using data derived from the analysis of artifacts and the behaviors associated with their production and use.

Function

Technological approaches to tool function have generally taken the form of microscopic or macroscopic use-wear analyses or replication experiments. Use-wear studies have concentrated on the development of discernable patterns of edge modification and polish formation on stone tools. Aldenderfer et al. (1989) have reported some success in correlating stone tools with various tasks. Combining results

derived from experimental replication and microscopic analysis of an artifact assemblage from the Petén Lakes region, the authors found that general trends in the character of wear can broadly distinguish between various functions – particularly for tools used for a greater duration (Aldenderfer et al. 1989:51-53). The authors also found that few tools were multifunctional. This contradicts the findings of researchers at other sites who have shown that many tools were used for a variety of tasks, and that tools were commonly recycled to extend the material use life (Clark 1988; Dockall and Shafer 1993; McAnany 1988, 1989b; Shafer 1983). Aldenderfer et al. (1989:53-54) further state that tool design was better correlated with action or motion of use than it was material worked, finding that most of the utilitarian tools recovered (mainly large-mass) were made from poor quality local materials, while tool forms they identify as employed for wood working are made of high quality non-local materials. They assert that imported tools were used in industrial or specialist contexts. However, it is also likely that material choice was related directly to function and not related to social status. Material choice may reflect a concern for edge angle, recycling, type of use, or durability.

Other researchers have examined the use of products manufactured in Colha workshops among different consumer localities. Shafer (1982b) showed through microscopic analysis that celtiform bifaces at Colha, Kichpanha, Cuello, and El Pozito are characterized by distal impact fractures and slight polish, suggesting of work with tropical hardwoods and palms, while Kokeal celtiform bifaces exhibit extensive distal abrasive striations, probably due to their use in the construction and maintenance of raised fields at Pulltrouser Swamp (1983). This suggests that tools were not manufactured with specific functions in mind, but rather with a range of functions in mind. In a complimentary study Santone (1993, 1997) examined the distribution of different tool forms away from their production loci. Santone found that utilitarian tools capable of multifunctional use were more extensively distributed along the long-distance exchange network than those with restricted utility.

The functional analysis of Maya tool assemblages has benefited from numerous experimental studies that have attempted to replicate native patterns of tool production and use. Shafer (1979a) outlined the various experimental studies in lithic production that were conducted at the site of Colha prior to major excavations at the site. These studies were initiated as a compliment to functional analysis of Maya stone tool assemblages, and were instrumental in distinguishing temporal changes in technological and behavioral patterns at the site. Clark (1988) used replication experiments with obsidian at La Libertad, Chiapas, as well as microscopic and macroscopic analysis. Through these analyses Clark found that many tools were multifunctional (1988:34). In another example, Lewenstein (1987) was able to present a strong case for woodworking at Cerros by combining artifact replication with microscopic studies of use-wear on stone tools recovered at the site.

Lewenstein (1987) completed a rigorous program of experimental tool use at the site of Cerros, Belize, studying the wear received on tools resulting from their employment in various tasks. The results of these experiments were used to interpret use wear patterns detected microscopically on stone tools recovered in archaeological excavations at Cerros. The objective of Lewenstein's research was to study the prehistoric economy at Cerros and to formulate a model of community behavior. Economic models considered in the study related to the level of lithic craft specialization present at Cerros. Lewenstein compared her findings to heuristic behavioral models predicated on cross-cultural social anthropological and archaeological literature, finding that archaeological data at Cerros support low-level specialization in processing and manufacture most strongly (1987:199). This pattern reflects the presence of few specialists operating on a decidedly part-time basis for the benefit of the local community (1987:21-22).

Finally, significant contributions to the functional analysis of Maya stone tools include works by Clark (1988) and Aoyama (1999). The works of Clark and Aoyama offer only a cursory examination of chert industries, however, concentrating their attention more heavily on obsidian processing and consumption. Thus, these studies are

not reviewed in detail here. Aoyama's work represents a tremendous advance in use-wear analysis that combines a rigorous experimental program with the analysis of obsidian blades recovered in archaeological excavations in the Copan Valley and La Entrada region of Honduras. Clark preset a thorough description and analysis of all lithic artifacts from La Libertad, Chiapas, Mexico. Although Clark does offer a descriptive analysis of chert and groundstone artifacts and industries, the majority of attention is given to the analysis of obsidian tool forms. The works of Aoyama (1999) and Clark (1988) are benchmarks in the analysis of Maya stone tools.

Behavior

Shafer (1982a) has identified the presence of craft specialization in northern Belize based on the skill exhibited on the part of lithic craft producers and evidence of commercial production. The skill of Colha artisans is exhibited in the standardization of manufacturing techniques, the low volume of raw material waste per unit of manufacture, the relatively low incidence of production errors and standardization of recovery techniques, the significant degree of standardization observed among finished products and production waste, the enormous volume of waste material, and the use of manufacturing techniques that maximize production efficiency vis-à-vis time, labor input, and raw material usage. Shafer (1982a:37) accounts for the anomalous presence of intensive, long-term lithic craft production in northern Belize workshops by emphasizing the unique nature of chert outcrops within the region, stating that "the lithic craft specialization documented at Colha can only be understood when viewed as a regional phenomenon." Opportunistic behavior is implicit in the explanation Shafer provides for the origins of the northern Belize craft economy. Counter this, McAnany (1991:277) writes that systems supporting full-time craft specialization will be characterized by "such an acute land shortage that individuals have no option but to replace agrarian production with craft production." Current archaeological evidence suggests that craft specialization developed at Colha well in advance of population stress on natural resources. The view of full-time specialization advocated by McAnany seems

to inadequately account for opportunistic behavior oriented toward maximizing economic returns on invested labor.

Michels (1979) also noted the presence of craft specialization in his study of obsidian tools in household assemblages at Kaminaljuyu. Michaels based his assessment of craft specialization on the non-regular presence of obsidian craft production among households at the site, and the nucleation of households exhibiting evidence for such production (Fowler 1991:5). This form of specialization is distinct from the community specialization observed at Colha, and characterizes specialized households within a non-specialized community (Fowler 1991:5). Clark (J. E. Clark 1991b) studied the behavioral patterns associated with household craft specialization. In his study of modern Lacandon blade manufacture, Clark provided a model derived from ethnoarchaeology for detecting domestic workshop deposits in the archaeological record that challenges many of the preconceptions held by researchers regarding the type of evidence used to determine the presence of such a feature.

Some researchers have discounted the presence of full-time craft specialization in the Maya lowlands based on comparisons between lowland industries and the industries of highland Mexico (Clark 1986). In reply to this Fowler (1991:6) writes that “on present evidence it would appear that as far as specialization in lithic production is concerned, that of Teotihuacan is not remotely comparable to that of Colha.” The location of production centers, such as Colha, outside of large urban settings has also undermined the recognition of craft specialization within the Maya lowlands as it does not conform to expected patterns of urbanized specialization as found at Teotihuacan (cf. Fowler 1991). Although the specific character of lithic industries may be expected to vary based on the availability of raw materials, the quality of raw materials, regionally-adapted subsistence practices, and the intensity of demand, it appears clear that lithic craft specialization, at various orders of production intensity and scales of community involvement, was well represented in the Maya lowlands.

One of the fundamental areas of contention in accepting the presence of full-time craft specialization in the Maya lowlands has been reaching an agreement on what

constitutes material evidence for “full-time” labor investment. Full-time production involves devoting all labor efforts toward the creation of a craft surplus that can be exchanged for basic subsistence resources and other desired commodities, but this can be difficult to demonstrate archaeologically. Outside of Colha, Belize, evidence for full-time specialization in lithic craft production is rare and at best equivocal in the lowlands. Lithic workshops that supported a community of consumers through intensive, even long-term production have been reported from several sites in the Maya lowlands in association with localized nodes of productive raw material. Dense area of lithic debris tentatively identified as workshop deposits have been reported at San Jose (Thompson 1963:236), western central Belize (Bullard 1960), and Chiapas (Brunhouse 1976). Lithic production workshops have been definitively identified at Bedrock (Barrett 2003), Chau Hiix (Cackler, et al. 1999), Rio Azul/El Pedernal (Black 1987; Black and Suhler 1986), Chan Chich (Meadows 2000; Lindeman and Guderjan 1991), El Pilar (Ford and Olson 1989); Kichpanha (Shafer 1982b), Maskall (Gibson 1982), Sand Hill, Chicawate, and Kunahmul (Taylor 1980), and Rockstone Pond. Only production deposits at Chan Chich and El Pedernal have proven to be as massive as those at Colha, though neither exhibits the time depth or proliferation of those at Colha.

Contextual Approaches (Top-down) – Questions and Methods

Procurement

Contextual approaches to resource procurement place greater emphasis on the mobilization of resources through regional and long-distance commercial networks than they do the heterogeneous distribution of raw materials across landscapes. Landscape variability is not wholly ignored in such works however, as illustrated in the assertion by McAnany (1991:279) that there are no truly resource deficient areas in the Maya lowlands, and that exchange networks may be better thought of as conventions rather than as necessities as all areas were essentially self-sufficient in commodities (1991:281). She further states that stone had many suitable substitutes as a medium, pointing out that island settlements lacking utilitarian stone resources often used shell

tools. This does not, however, address the fact that the lowlands are markedly heterogeneous in the distribution of utilitarian stone, nor does it address the fact that shell was not suitable to all tasks. Island settlements also lacked abundant supplies of consolidated limestone, and thus architecture tended to be more frequently perishable, and the stone tools needed for quarrying limestone and constructing masonry architecture (see Eaton 1991) were not necessary for island communities. Utilitarian stone does, however, lack suitable substitutes for the lifeway followed by most inland Maya communities. McAnany's statement also fails to consider the non-renewable nature of lithic resources. Once self-sufficient settlements may have well found themselves in the position of having to import stone tools over time as the expansion of population and architectural programs exhausted locally available supplies of utilitarian stone.

Contrary to McAnany's assertion, Rovner (1976:41) states that "no particular locality possessed the full range of lithic resources to fill completely their basic utilitarian needs through time, much less their ceremonial requirements." Rovner's characterization of utilitarian lithic resources in the northern lowlands is one of marked heterogeneity in quality and absolute availability. This recognition provides the necessary foundation for appreciating the reasons why resources were mobilized from exceptionally productive areas to areas of scarcity.

Archaeologists clearly differ in their view of polity self-sufficiency, the impact of which being most evident in its influence on how researchers view the social, economic and political role of regional and long-distance commercial exchange. Marcus (1983:477-479) has described commercial trade in Mesoamerica as being intraregional, interregional, or long-distance in nature. In this work I distinguish between resources exchanged locally within the Blue Creek settlement zone, resources exchanged regionally between sites in northwestern Belize and adjacent areas of southern Mexico, and resources exchanged over long distances (commodities imported from areas outside of the northwestern Belize regional interaction sphere). The central question applied to

the exchange of resources in any form concerns motivations and the means of mobilization.

Colha has yielded some of the best documented evidence for intraregional trade in the Maya lowlands (McAnany 1989b; Shafer 1983). Colha material has also provided evidence for interregional exchange (Gibson 1986; Hester and Shafer 1994; Shafer and Hester 1991). To a lesser degree, Colha products have provided evidence for long-distance exchange (Clark 1988), though there is less certainty as to whether such exchange was commercial or ceremonial in nature. McAnany states (1991:276) that the “task now remaining is to understand the form of exchange under which these [Colha] tools circulated and the extent to which the form of exchange was politically controlled or manipulated.” Braswell (2002) has similarly addressed this problem with respect to obsidian tool production at San Martin Jilotepeque, Guatemala. Scholarly understanding of ancient Maya macro political and economic systems remains somewhat opaque. Spheres of political and economic influence related problematically, particularly during the Classic period where chronic political unrest in the central lowlands appears to have had little affect on patterns of commodity consumption. In another example, it is unclear what benefits Colha artisans received in exchange for their craft products – if they received anything at all. Imported igneous (granites, basalts, greenstone) groundstone artifacts are found in modest degrees at Colha, though quantities are not in access of regional norms, and are far below those at Altun Ha and Lamanai where there is no evidence for intensive lithic craft production for regional markets. Viewing Colha as a locus for tributary craft production, administered by a higher order regional polity, possibly Altun Ha (Shafer 1982a: 36), is not inconsistent with site data from Classic period deposits. Within the lowlands, arguments of heterarchical control over hinterland craft production (King and Potter 1994; Potter and King 1995) argue against the administrative control over production economies, though I find the logic of such arguments to be myopic and devoid of a larger systemic perspective.

Freidel et al. (2002) have suggested that the acquisition of exotic commodities through long-distance exchange was central to the legitimization of elite institutions and

noble authority. McAnany (1991:287) has contrasted the flow of luxury and utilitarian goods in both nonhierarchical and hierarchical social systems, finding that once a system becomes stratified the acquisition these goods occurs through distinctly different channels with social controls emplaced on their degrees of access. Hay (1978:117) has argued that economic inequality at Kaminaljuyu was predicated on the alienation of sumptuary goods and select strategic resources from the population at large, with access to these resources facilitated through chiefly redistribution.

Santone (1997) has shown that the efficiency of transportation systems impacted the distribution of commodities, though higher-valued items that appealed to ideological rather than utilitarian desires may have been considerably less restricted. Indeed, the value and desirability of such objects may have benefited (or even depended) on the extraordinary effort invested in their acquisition. However, ceremonial commodities account for only a very small fraction of the goods transported in commercial networks by the Maya. Several authors have made significant contributions toward understanding the role of canoe transport in Maya long-distance trade (Freidel and Scarborough 1982; McKillop 1980; McKillop 1995, 1996; Santone 1993, 1997; Shatto 1998). The organization of a regional market economies and the use of waterborne transport are interrelated topics, and each are in need of more in-depth consideration.

The logic used in constructing trade models has been directly questioned by a number of authors. Fowler (1991:10) has stated that most economic models used in the Maya lowlands employ various ratios, indices, and distance measures that are flawed by a formalist bias that presupposes a tendency for societies to function according to principles of economic maximization. Similarly, McAnany (1991:276) argues that the organization of exchange systems “has been modeled using formalist’s assumptions about supply and demand, discriminatory pricing, and profit motivation; corn surplus has been equated with the convertibility of monetary currency.” McAnany goes on to advocate an increased use of ethnographic examples of trade and exchange systems in constructing more complex models of trade among the ancient Maya.

Technology

Top-down approaches to lithic analysis in the Maya lowlands seldom deal specifically with the particulars of technological systems. However, studies that have described changes in production systems based on dramatic changes in subsistence (Barrett 1999), as well as those that have suggested the introduction of foreign cultural elements as the catalyst for observed changes in production technology (Rovner 1975), may be classified as contextual approaches.

Function

Andrews and Rovner (1975) provided a functional analysis of two stone tools assemblages from the northern lowlands that is best classified as a contextual approach due to its concern for how these tools reflect social status and a specialized context of use. The authors described two “masons’ caches” discovered in sub-flood caches at the sites of Muna and Dzibilchaltun, Yucatan, Mexico. Each cache contained a number of seldom reported classes of tool, and all tools were believed by the authors to have been used by Maya stucco masons in activities relating to the construction of buildings or plastering of their facades (1975:88). Contextual evidence suggests that the Muna cache dates to the Late Classic period, while the Dzibilchaltun cache dates to the Early Classic. Each cache contained a number of tools referred to as “smoothers”, which I have elsewhere described as stucco polishers (Barrett 2000a). Another tool, described by Andrews and Rovner (1975: 84, 87) as a “brick-shaped smoother, resembles a sharpening or honing stone documented at Blue Creek. The Blue Creek tool was fragmentary, but its width and thickness are comparable to the Muna specimen. At Blue Creek, the tool was crafted from locally available quartzite, whereas both the Muna specimen and a non-cache Dzibilchaltun specimen were crafted from limestone. All visible surfaces of the Blue Creek specimen were finished in the fashion of most groundstone artifacts. One face was unmistakably beveled, and the curvature of this bevel matched the topography of the ground and polished distal margins of the ground-bit celtiform tool type exactly. It was evident that the sharpening stone was used in

crafting the polished bit of celtiform tools, explaining the remarkably consistent dimensions of these tools. Furthermore, a notch was observed along one margin of the Blue Creek specimen that was likely used for finely honing the distal bit of the celtiform, as the bits of several tools fit seamlessly into the notch.

Functional was ascribed to the cache tools based on the composition of the caches, as well as the fact that the surfaces and fracture crevices of many tools were heavily encrusted with plaster (Andrews and Rovner 1975:88). However, Andrews and Rovner (1975:89) add that the “specific function of these tools in the preparation, formation, and final elaboration of the plaster media of the mason’s craftsmanship remains largely indeterminate.” The tool assemblages found within the Muna and Dzibilchaltun caches likely reflect a greater range of tasks than those associated with stucco masonry. The adzes (ground-bit celtiforms) are particularly out of place in this limited range of activities. Rather, the caches may better reflect the functional assemblage of an architect, whose range of tasks extends to quarrying limestone and shaping it into blocks for architectural use, as well as cutting and finishing timber for use in building structural frames and for rendering limestone into plaster (Abrams 1994; Eaton 1991). The report of Andrews and Rovner (1975) provides valuable insight for distinguishing functional sets of tool types, illustrating the importance of approaching tool function and human activity through complementary sets of artifacts. Stone tools have the potential of offering greater insight when they are analyzed as part of a functional assemblage rather than in isolation.

Behavior

Contextual approaches to lithic analysis have been most prolific in addressing patterns of behavior, which may be surmised from the emphasis these works place on the social context of institutional activities. Topics covered by such works include the level of hinterland autonomy with regard to craft production and other economic endeavors, the nature of craft specialization, the origins of interregional and long-distance exchange, and the material correlates of ritual behavior.

The autonomy of hinterland communities has recently become an intensely debated topic among researchers in the Maya lowlands (Lewis 1995; Lohse 2001; Potter and King 1995; Scarborough, et al. 2003). Archaeologists have offered differing opinions regarding the extent to which large regional centers administered the dispersed economies of their hinterlands, whether through controlling labor, restricting common access to productive economic resources, or by demanding tribute payments. Such relationships were likely negotiated on a regional basis, with no one set pattern in effect for the lowlands as a whole. The coercive power of regional political entities also likely varied through time as the power of ruling lineages waxed and waned. Stone tools represent a highly visible and economically vital resource that is ideally suited to explicating these relationships. For example, Shafer (1982a:32) offered the theory that Altun Ha may have controlled production sites in the northern Belize chert-bearing zone during the Late Classic period based on the clear fact that Colha received little economic benefit from craft production. Although Colha regularly supplied vast areas of the Maya lowlands with utilitarian and ritual products for over a millennium, the site remained relatively small spatially with no imposing architecture, and exhibits only modest socio-economic stratification among its populace. Much more research needs to be done on this topic to better illuminate this relationship, and it would be prudent to explore the site's Early Classic relationship with its larger northern Belize neighbors. There is reason to suggest that the Early Classic period presents a much more likely time for Altun Ha to have enjoyed supremacy over the commercial endeavors of Colha, while Lamanai may have maintained similar influence during the Late Classic and Postclassic periods.

King and Potter (King and Potter 1994; Potter and King 1995) have discussed the changing patterns of production at Colha, making the case for the heterarchical organization of craft production at the site. The authors argue that there is no evidence at Colha for centrally administered and regulated production, and that households are likely to have made independent decisions with regard to their level and manner of participation within the general program of craft production at the site (Potter and King

1995:28). The volume of workshop production, as well as the specific tools produced, would then have been regulated by individuals or corporate groups in the absence of a larger administrative entity. In support of their theory, the authors point to the dichotomous distribution of utilitarian and ritual lithic craft items at lowland consumer localities, stating that luxury forms (such as eccentrics) flowed through hierarchical channels while utilitarian forms (such as tranchet-bit tools) traveled through heterarchical channels (Potter and King 1995:28). Ultimately, this heterarchical view of lowland Maya economic organization has several significant flaws. First, it assumes that peripheral sites could not have been administered by distant central places. Secondly, there is no logical link between the use of utilitarian goods by commoners, the possession of higher status goods by elites, and heterarchical economic organization. Local administrators may well have organized craft production in hinterland communities under the aegis of central place elites whose authority was partially legitimized through their ability to distribute resources efficiently across regional networks of economically linked consumer sites. Furthermore, in explaining the dichotomous distribution of utilitarian and status objects through the coexistence of heterarchical and hierarchical systems of redistribution, the heterarchy model fails to consider functional differences that existed between elite and non-elite households that may have influenced the structure of craft assemblages. The heterarchical model also fails to consider the disproportionate distribution of convertible resources within lowland communities, as well as the realized cost of commodity acquisition.

Adams (1970) was among the first to suggest that occupational specialization was both present and common throughout the Maya lowlands. The evidence used by Adams, however, was largely circumstantial. In his view, the exemplary workmanship observed in the construction of Maya architecture, production of hieroglyphic monuments, and manufacture of stone tools and polychrome ceramics was clear evidence for the presence of craft specialists. Andrews and Rovner (1975) went so far as to suggest the presence of craft guilds. The first unequivocal evidence for the presence of craft specialists, however, was provided through Shafer's analysis of chert workshops

at Colha, Belize (Shafer 1981, 1982a, 1994; Shafer and Hester 1991). Once the existence of craft specialization was generally accepted (see Mallory 1986; Moholy-Nagy 1990; Shafer and Hester 1986), scholarly attention turned to inferring various attributes of lowland political and economic organization by attempting to identify the specific forms of specialization that existed.

Costin (1991) has identified several forms of independent and attached specialists. Forms of independent specialization include individual specialization, dispersed workshops, community specialization, and nucleated workshops. Forms of attached specialization include dispersed corvee, individual retainers, nucleated corvee, and retainer workshops. Hinterland workshops remain largely autonomous where independent specialization exists. In contrast, elites maintain some level of control over craft labor or workshop production where attached specialization exists. Attached specialization is a vital component of wealth finance systems that support the development and maintenance of elite institutions, including the bureaucratic mechanisms of the state (Brumfiel and Earle 1987b; Earle 1989).

Lewis completed an economic analysis of several sites in the Three Rivers Region of northwestern Belize and eastern Guatemala (Scarborough, et al. 2003) in an attempt to identify and characterize craft specialization occurring in the region. According to Lewis (1995:46), the importance of making a distinguishing between attached and independent specialization is to emphasize the varying political and economic motives of demand (Earle 1981; Brumfiel and Earle 1987b), distinguish between the contrasting “product rights of authorization” [Giddens 1984; Clark and Parry 1990], and to illustrate the contrast in rights of product acquisition. Lewis (1995:25-26) contrasted managerial models with political (or control) models that emphasize the development and maintenance of inequality as a key motivation in the control of production and exchange by elites. In the logic of such models, state formation is the inevitable outcome of actions of a small number of self-interested individuals. State formation is dependent on the accentuation of divided interests and the development of distinct social and economic classes which compete for resources

and influence. Groups are dialectally opposed to one another, with the distribution of power predicated on differential control over the means of production (Lewis 1995:249) Maya can be viewed as employing a system of staple finance.

Lewis' (1995:54) findings support the notion that separate systems of production existed among the ancient Maya; one comprised of independent specialists producing utilitarian crafts without considering the needs of individual clients, and the other comprise of attached specialists producing luxury items. However, McAnany (1989b) has shown that different client sites in northern Belize received compositionally different tool kits from Colha. This suggests that producers were aware of the specific utilitarian needs of consumers. Furthermore, the mass production of stemmed blades at Colha during the Terminal Classic period appears also to have been in direct support of consumer demand. This shows that if such commodities were produced by independent specialists or specialist communities, specialists were flexible in response to changing consumer demand. Alternatively, intensive craft production in northern Belize may have occurred in the form of nucleated corvees or retainer workshops that were controlled by a managerial elite. As for the production of specialty items being limited to attached specialists, it is interesting that the strongest evidence of production specialization within the Blue Creek community comes from the Rio Hondo community. This community is arguably among the poorest in the Blue Creek settlement zone, and it is located at the periphery of the community at a considerable distance from the elite settlement zone.

Theories on the origin of interregional and long-distance exchange among the Maya were already discussed in detail in Chapter II and will not be reiterated here. Briefly, however, scholars have offered that the motive for extra-regional exchange is based on the discontinuous distribution of material resources throughout southern Mesoamerica (Service 1962, 1975). Models have claimed that the heterogeneous resource structure of the lowlands necessitated a centralized managerial elite responsible for coordinating local subsistence intensification efforts and promoting stable market exchange to ensure the security and viability of the local community (cf. Sanders 1956; Wittfogel 1972). Freidel (1981) offered a mechanism promoting interregional exchange,

suggesting that elites coordinated the production of local surplus that was subsequently distributed across the lowland landscape through pilgrimage fairs. Rathje (1972) proposed a model that continues to be periodically influential, though with substantial revisions, by which administrative elite within the resource poor, ideologically rich central zone (cultural core) exchanged esoteric knowledge with the resource rich, culturally retarded periphery. If the motivation for the core was to obtain locally unavailable commodities, the periphery's motivations were considerably more opaque in Rathje's model.

Lithic research in the Maya lowlands has brought greater resolution the study of commercial exchange systems. Researchers have had success in tracing the distribution of chert tools from their manufacturing loci, particularly those emanating from production sites in the northern Belize chert-bearing zone (Gibson 1986; Hester and Shafer 1994; Hester, et al. 1991; McAnany 1989b; McKillop 1996; Shafer and Hester 1991). Also, Santone (1997) has shown that the distance commodities traveled was influenced by the ceremonial vs. utilitarian nature of the craft item, as well as the availability of waterborne means of transport. Absolute scarcity, proximity of available alternatives, and network security were also likely to have been influential in determining the spatial scale of resource distribution. Contextual approaches in lowland Maya lithic analysis have contributed significantly to the study of inter-community and long-distance exchange. Such efforts have benefited from the heterogeneous distribution of lithic resources throughout the lowlands, the durability of this resource in the archaeological record, and the wealth of information that is able to be gleaned from the study of formal tools and material waste relating to lithic resource procurement, processing, distribution, use, recycling, and discard.

Lithics artifacts, whether in the form of elaborate *objects d'art* or simple, unmodified flakes, are common elements within lowland Maya ritual deposits. Moholy-Nagy (quoted in Fowler 1991:4) has stated that large obsidian and chert deposits discovered in votive caches and exterior tomb deposits at Tikal are redeposited waste from lithic workshops. However, analysis of contextually and compositionally similar

caches at Blue Creek and elsewhere have shown that such deposits are often produced specifically for their deposition within such deposits and are not redeposited workshop debris. At Blue Creek, chert debitage associated with a tomb at Structure 9 was determined to have been knapped specifically for votive deposition. The chert used was an untreated local coarse chert that is invariably heat treated when recovered in clear production deposits. Further, the 708 flakes in the tomb deposit lacked cortex, had unmodified lateral edges, exhibited no evidence of platform preparation, and were all approximately the same size. In sum, they were wholly dissimilar to production assemblages found elsewhere at the site.

Potter (1994) found a chert blade with human blood residue cached atop a small Late Preclassic mound at Colha, Belize. The contents of the cache were interpreted as the remains of a blood-letting ritual, similar in principle to the scenes of autosacrifice so commonly depicted in Maya iconography (Schele, et al. 1986). Meadows (2001) has recently made a substantial contribution to understanding how artistic processes and lithic craft items both reflected and supported social ideologies. Artisans produced symbolically-rich chert eccentrics at different localities in northern Belize from the Late Preclassic through Terminal Classic periods. Eccentrics were likely to have played an important role in the materialization of state-sanctioned ideology during ceremonial observances, and are thus an identifiable tool of political office. Whether the craft specialists who produced eccentric forms did so as attached laborers or as independent specialists under commission or as a form of tribute remains to be explored.

Comparing the Utility of Each Approach and Defining a Synthesis

There are few works that incorporate both technological (bottom-up) and contextual (top-down) levels of analysis (but see Aoyama 1999; Shafer 1983), which has caused the broad relevance of lithic artifact data to larger cultural-historical concerns in Maya scholarship to remain either wholly unestablished (cf. Hester 1976), or else appear to lack adequate foundation. The reality remains that nearly all archaeological projects in the Maya area employ a ceramic specialist while very few have a lithicist on staff.

Until lithic analysis ceases to be an ancillary concern in the Maya lowlands, archaeologists can do little more than speculate as to the economic structure and variability present among lowland Maya polities.

It is with this perspective that I envision the contribution of this work. While studies of process are a basal necessity in archaeological inquiry, the importance of processual data is best appreciated in terms of its relevance to the general threads of culture history. This historical perspective is requisite for discerning how various culture processes related to one another synchronically and diachronically. This is evident when considering how tool production related to changes in subsistence (Barrett 1999, 2000b), or how it related to socio-political changes such as episodes of increased militarism and warfare (Barrett and Scherer 2002; Rovner 1975; Rovner, et al. 1997). Temporal patterns of resource use at Blue Creek can only be meaningfully interpreted with respect to the changing character of the community. Blue Creek's internal socio-political structure, its political and economic relationship with neighboring sites in northwestern Belize and southern Campeche, Mexico, the pressures that exponential increases in population placed on local environmental resources, and the stability of long-distance exchange routes must each be considered in applying lithic artifact data in an informative fashion to broader cultural processes.

Methodology in Debitage Analysis

There are only a few significant studies of non-obsidian production waste that have been produced by researchers in the Maya area. All have been produced in the last three decades, and most are associated with the Colha project. The first flake analyses were, however, performed on obsidian. Davis (1975) used microwear analysis on obsidian flakes from Altamira, Chiapas in an effort to discern whether or not the pieces were used in manioc grater boards. Although he found wear patterns on experimental flakes used in this fashion to exhibit analogous wear, other researchers have shown diverse activities to produce similar wear patterns (Lewenstein and Walker 1984). The

same year (1975) Hester used microscopy to inspect bifaces and unifaces from the highland Guatemala site of Beleh.

Shafer (1976) produced one of the first detailed analyses of chert debitage in the lowlands, showing that the ubiquitous “orange peel” artifacts at Colha were waste flakes rather than tool forms. Another study of debitage and rejected production forms by Shafer (1979b) at Colha was instrumental in defining the technological system used in tool manufacture at the site. That study also highlighted the fact that a distinctly different technological system was employed during the Postclassic period. In a further study, Shafer (1983) analyzed tool forms and debitage recovered in excavations at Pulltrouser Swamp, showing the existence of a distinct producer-consumer relationship between the two sites. The Pulltrouser Swamp lithic assemblage was comprised by-in-large of heavily recycled tool forms that had been initially manufactured at Colha rather than being produced out of the inferior raw materials that were available locally. Reomer (1984) has produced a detailed study of waste flakes and rejected tool forms from Classic period workshops at Colha, describing changes manifest in the blade industry through time at the site. Michaels (1987) has conducted similar research with respect to Postclassic workshops at Colha, again describing temporal changes in stone tool production. In one of the few detailed analyses of chert flakes outside of northern Belize, Aldenderfer et al. (1989:56) examined deposits from the central lowlands finding that ad hoc tools made from waste flakes were used for a greater number of tasks than formal tools. The authors further found that ad hoc tools overlapped in function with formal tools in many instances, and that they were least limited with respect to contact material.

Studies of lithic waste material in the Maya lowlands have shown minor alterations and wholesale changes in technological traditions, they have distinguished between loci of domestic production and areas of intensive craft industry, they have provided evidence for raw material scarcity and resource conservation, and they have identified behavioral patterns ranging from the utilitarian to the ceremonial. Still, however, the study of debitage in the Maya lowlands remains largely ignored. Few

projects employ adequate recovery techniques, either failing to properly screen excavated material or, perhaps more commonly, failing to excavate enough off-mound contexts to allow for an objective behavioral analysis. Those flakes that are recovered typically remain of secondary concern, and information garnered from their study seldom makes its way into broader theory. A fine-grained study of lithic resources that incorporates data from debitage and ad hoc tools as well as formal tools is a critical component of any meaningful analysis of how the Maya adapted to the allowances and limitations imposed by the mosaic distribution of natural resources across the lowlands.

Critique of Maya Lithic Research

Several problematic aspects of Maya lithic research were highlighted by Fowler (1991) in his review and critique of Maya lithic research. First among these was the fact that ceramic associations have, with very few exceptions, been used as the means for dating lithic artifacts from the earliest phases of scientific exploration in the Maya lowlands to the present. While Fowler advocated the establishment of stone artifact chronologies independent of ceramic chronologies, that fact is that the stylistic attributes of ceramics provide a more sensitive indicator of temporal change. Changes occurring in lithic industries are typically slow to evolve, and may not be as discernable as those typifying ceramic industries. However, those changes that do occur in lithic industries may provide a great deal of information relating to subsistence programs and external cultural influences, and are thus important to distinguish for reasons other than their ability to chronicle discrete intervals of time.

Fowler (1991:12) also addressed the need to better define linear-reduction models characterizing distinct industrial traditions, advising that more attention be given to investigating production, including discarded tool forms and waste material. This concern remains salient. Outside of northern Belize, little attention has been given to identifying specific technological traditions and defining the spatial and temporal patterns of their occurrence (but see Aoyama 1999; Rovner, et al. 1997). As greater emphasis is given in Maya archaeology toward discerning how local communities were

impacted by radical changes in political alliance, including the likelihood of large-scale populations movements, it would that a detailed analysis of technological systems would have much to add. The absence of a macroblade production tradition at Colha during the Postclassic period, a tradition which had been a hallmark of production at the site for over a millennia, and its replacement with production tradition derivative of the Petén, speaks volumes about the social changes that occurred at the site following its abandonment in the eighth century (Barrett and Scherer 2002).

Fowler's critique further called for a greater investment of research into patterns of tool consumption, pointing out the unique utility of stone tool data in illuminating the dynamics of economic systems. In a related suggestion, Fowler advocated directing greater attention to systems of local and regional exchange. Such efforts would benefit tremendously from an increased research emphasis on determining the degree of local and regional raw material variability, particularly with the identification of specific material procurement loci as has been done in this work. Greater success in such efforts would enable a clearer picture of intracommunity differences in resource access, and would compliment research directed at assessing the nature of craft specialization within communities (cf. Lewis 1995). Tool consumption patterns could also provide an invaluable compliment to studies of subsistence intensification. Production industries have been shown to be sensitive to changes in subsistence regimes (Barrett 1999, 2000b). Researchers investigating the inception of intensified agricultural systems in the Maya lowlands have focused their attention almost exclusively on the development of raised and/or channelized field systems through geoarchaeological investigations. To my knowledge, none of these studies have looked at whether changes in subsistence production coincident with the origins of raised field agriculture are reflected in stone tool production systems or lithic material consumption patterns.

The final critiques offered by Fowler call for a more rigorous approach to investigating stone tool function, and advocate a heightened use of replicative experiments and inclusion of ethnographic and ethnohistoric data. According to Fowler (1991:12), a greater reliance on empirical observations derived from experimental

studies, combined with behavioral studies of living groups (cf. Hayden 1987a), and the use of Colonial texts (cf. Tozzer 1941), will afford a means to link archaeological inferences to material evidence with greater precision. While some important experimental research into stone tool function has been concluded in the last decade (see Aoyama 1999), it has been largely focused on obsidian tool forms. Traces of wear on obsidian tools are undeniably more easily observed, but this does not obviate the need for increased attention to chert and chalcedony tool forms, particularly in light of their greater range of functionality and greater overall importance to lowland Maya economic systems. Ethnographic research into stone tool production and use offers limited utility as the use of metal tools has supplanted that of stone with few exceptions. Stone tools are used for a limited range of tasks, with groundstone industries surviving with the greatest level of integrity. Still, the work of Hayden and others in highland Guatemala (J. E. Clark 1991b; Hayden 1987b, c; Lee and Hayden 1988; Nelson 1987a, b) has provided valuable insight with regard to behavioral patterns governing the organization of production, and the processes responsible for removing traces of such activity from the archaeological record.

Many of Fowler's critiques remain valid, though considerable progress has been made in the last decade toward addressing these concerns, and I would estimate that the state of lithic research in the Maya area is currently that of forward progress. However, there still remains a salient disparity in the analytical attention given to objects of chert and obsidian. Significant progress in elucidating the specific character of lowland Maya economies, with a particular emphasis on their variability across landscapes and regions, can only come about by bringing the study of non-obsidian tool forms to the forefront of research agendas.

Ultimately, future growth in the study of lowland Maya economies and socio-political structure will benefit enormously from the systematic incorporation of fine-grained lithic analysis into archaeological research programs. Although significant work has been accomplished in the past few decades, a greater effort needs to be expended in

bringing the application of lithic research to the forefront in our attempts to illuminate both local area and broad regional cultural dynamics

CHAPTER V

METHODS USED IN LITHIC ANALYSIS

Laboratory Data Collection

I have designed the analytical format followed in this work specifically for Maya lithic collections and the range of questions that are appropriate to their analysis. Given the complexity of Maya civilization and the central position of stone tools within Maya subsistence technology it is necessary for analytical methods to be sophisticated in their design. Furthermore, such methods should be forward thinking, providing data applicable to research questions beyond the concerns of the immediate study.

My artifact analysis commenced by separating flaked stone artifacts into two general classes: formal tools and debitage. Formal tools are defined in this study as those forms that require a desired template or design. They are the end product of deliberate raw material modification efforts, and represent an idealized cultural template for a tool suitable for a limited range of functional objectives. In general, only those forms requiring multiple stages in their production are classified as formal tools.

“Debitage” is the term used to describe the material waste produced when raw materials are converted into finished, utilitarian products. Henry (1989:141) distinguishes between *debitage*, which he defined as “specimens with dimensions equal to or greater than tools [which] are considered to have had the potential of being made into tools”, and *debris*, which he defined as “specimens with dimensions less than those of the smallest tool [which] are not considered to have had the potential of being made into tools.” In this study I size graded all material waste and examined it for use-wear. Subsequent analysis of debitage clearly distinguished trends in the correlation between flake size and edge modification, but this does not necessitate the use of alternative terminology for small-sized items that tend to be unmodified. Also, making such a distinction based entirely on the logic of size constraints seems arbitrary. It assumes that consumption decisions in the past were based on similar logic rather than being a more dynamic processes that accounted for material scarcity, physical properties of the

material, and technological specifications. For these reasons, I use the term *debitage* exclusively in this study to describe all lithic production waste.

In distinguishing formal tools fromdebitage, a notable gray area exists whendebitage is itself used as an expedient tool (Binford 1979). While used flakes are in fact tool forms, they are not necessarily the product of intentional design and are therefore classified as flakes rather than tools. On the other hand, flake cores and blade cores are classified as formal tool forms due to the preparation required in their manufacture. Unlike used flakes, blades are classified as formal tools because they consistently exhibit a particular suite of characteristics. Asdebitage is occasionally “blade-like” in appearance, I classified only pieces with polyhedral dorsal facets as blades. This conservative approach has certainly underrepresented the number of blades in the sample, as blades with dihedral dorsal facets are excluded. However, as metric attributes, material composition, and use-wear were recorded regardless of formal classification, typological semantics need not interfere with the accurate identification of material use.

Clearly, the parameters separating formal tools fromdebitage -as they are defined in this work- are somewhat accommodating, but the purpose of distinguishing such categories of data is merely to provide an efficient analytical framework from which broad theoretical extrapolations can be made. All classes of stone artifact may be fitted within this framework without redundancy, attesting to the efficacy of this analytical format. A total of 2136 formal tools and 24,944 pieces ofdebitage were analyzed in this study.

Procedures

In the field laboratory, stone tools were each assigned a unique specimen number. Artifacts recovered before the 2001 field season had been assigned a sequential “special find” number. Beginning in the 2001 field season, the Blue Creek project employed a new coding system for all artifacts that integrated context information into the unique specimen number. Context information recorded included locality, structure,

operation, sub-operation, and lot. Chronological information was assessed for excavated lots based on ceramic associations.

Metric measurements that I recorded in the analysis of formal tools included length, width, thickness, weight, and edge angle. I used calipers to record length, width, and thickness to the full millimeter. I measured edge angle with a goniometer, with angles rounded to the nearest multiple of five. I recorded weight to the nearest gram using an *Ohaus* digital scale with a 3000 gram capacity.

Raw Material Sourcing

I analyzed all artifacts included in this study in the field, except for approximately 75 artifacts which had been exported to the United States. This has placed certain methodological limits on the study. For example, I studied all artifacts using a 10x power hand lens rather than with higher magnification. This has permitted only macroscopic analysis of tool features and use-wear. While Andrefsky (1998) has demonstrated the broad utility of macroscopic lithic analysis, the identification and examination of organic and inorganic residues was not possible. Also, Keeley (1977) has shown that microscopic examination of polishes can distinguish between various contact materials, though this assertion has been challenged (see Moss 1987). By this macroscopic examination, I identified the area of polish distribution, the depth of penetration from the lateral margin, and the relative degree of development of the polish, though finer scale characteristics could not be observed.

Finally, as chemical sourcing could not be performed in the field, I visually sourced artifacts using a comparative collection of material extracted from resource outcrops across northwestern Belize (see Figure 6). Chemical analysis of cherts from the northern Belize chert-bearing zone has shown that those materials are readily distinguished from chert sources outside that geographic region (Cackler, et al. 1999; Tobey 1985), but discerning amongst specific resource nodes within that region has not generally proven feasible. Compared to northern Belize cherts, lithic resources above the Rio Bravo escarpment in northwestern Belize appear to exhibit greater variability in

mineral composition (see Appendix B). As discussed in Chapter III, the geological history of northwestern Belize is distinct from that of northern Belize's marshy coastal plane (Lene 1997). The landscape west of the escarpment is dominated by irregular, mature karst topography, with sinkholes and broad, shallow valleys (*bajos*) lacking surface drainage. Mineral-bearing limestone deposits are exposed in much of this area due to the subsurface solution, fracturing, and collapse of bedrock strata. The character of these outcrops is highly heterogeneous, reflecting the dynamic processes of deposition and erosion that have affected this region through time, and this heterogeneity has allowed for accurate identification of raw material source locations based on visually observable material properties.

Mineralogical identification based on my familiarity with lithic raw material types was also aided by the material descriptions provided in various field guides (Bauer 1974; Schumann 1993). The traits I used to classify chert and chalcedony materials were color, diaphaneity, texture, relative grain size, hardness, the presence or absence of banding, and the composition of micro-fossils. I also developed a raw material type collection to ensure that materials were consistently identified throughout the sample. Several varieties of sedimentary quartzite, dolomite, silicified limestone, calcite, and quartz are also available in the project area, and I collected samples of these from natural outcrops and added them to the type collection. Identification of these materials was aided by observing their mineral structure, color, grain size, and hardness (Appendix B).

Material Alteration

Following raw material identification, I recorded physical and chemical alterations of the artifacts. Alterations may result from both natural and cultural processes, and evaluating the character of material alterations is an important step in identifying resource nodes, assessing an artifact's depositional history, and addressing the dynamics of resource utilization. Common material alterations that I identified within the Blue Creek lithic assemblage include heat discoloration, white patina formation, black patina formation, and iron oxide yellowing.

Many artifacts in the Blue Creek assemblage exhibit a white patina. White patinas commonly develop on cherts that have been buried in alkaline soils, forming on exposed surface areas (Luedtke 1992: 99-100). These patinas form through chemical weathering as cherts leach silica, purge carbonates, and are depleted of iron. Many cherts include a significant iron component (Tobey 1985), and the tendency for ferric compounds to stabilize through oxidation may encourage their dissolution from the outer surfaces of cherts. The surrounding soil becomes acidic as a result, causing the silica and carbonate components of the chert to erode, producing the characteristic white weathering rind (Luedtke 1992: 100). However, this is almost certainly not the only process by which such patinas form, as I have witnessed the formation of white patinas on chalcedonies while excavating a lithic workshop during the 2001 field season. Chalcedony flakes left in *situ* in excavated wall profiles developed an incipient white patina on their exposed surfaces over the course of several weeks, but developed no patina on the surfaces still imbedded within the soil matrix. In general, it appears that white patinas are less likely to develop on chalcedonies than they are on cherts, based on the analysis of the Blue Creek stone tool assemblage. Further, patinas that form on chalcedonies are invariably only thinly developed. This form of alteration is post-depositional in nature, and not likely to have affected material choice on the part of ancient artisans.

Iron oxide yellowing is not uncommon in the Blue Creek lithic assemblage, affecting 7.4% of formal tools (N=157). The staining is a chemical weathering process produced by oxidation of iron impurities located near the material surface, which manifests in a yellow-to-orange hue on light-colored materials, or an orange-to-brown hue on dark-colored materials. Oxide staining on cherts is most often superficial (< .1cm), and the original properties of the unaltered parent material are easily revealed through flake removal. Much of the variability observed in the study sample with regard to the manifestation of surface oxidation may be attributed to compositional variation in the chert parent material due to the presence or absence of various impurities (Tobey 1985). This variation may be the result of differential developmental processes between

geologic formations, or may have resulted from alteration processes affecting a single formation (Luedtke 1992). The presence and degree of oxide staining may also be affected by the artifact's depositional context, although the dynamics of this have not been tested. Stains penetrated more thoroughly into finer-grained, more highly diaphanous cherts, while chalcedony was not observed to stain, presumably due to the lack of iron in its composition. This form of material alteration is post-depositional in nature, and not likely to have affected the raw material procurement choices of ancient artisans.

I observed the effects of heat alteration on approximately 60% of artifacts studied. I also commonly noted reddening, a general increase in material opacity and luster, and the presence of crenellated fractures. Reddening occurs as heat causes iron impurities in the raw material to oxidize to hematite (Luedtke 1992: 94). The severity of reddening is influenced by the intensity and duration of heating, as well as the percentage of iron present within the raw material. Chalcedonies often contain significantly less mineral impurities than cherts, and may not turn a red hue when heated if they lack iron inclusions. Other colors resulting from fire alteration that were observed in the study sample included blue, black, brown, and yellow (Figure 27). Opacity increases with heat alteration as the result of an increase in microfractures throughout the material, causing the diffusion of incoming light (Luedtke 1992: 95). Crenellated fractures (often referred to as "potlids") occur when mineral impurities expand and contract at a different rate than the siliceous matrix surrounding them, as when materials are heated or cooled too quickly. This results in irregular, pitted scars (Crabtree 1972a:84; Whittaker 1994:73; Figure 28). Heating is presumed to have occurred either as a result of purposeful attempts to alter the mechanical properties of lithic raw materials, or perhaps as the incidental result of domestic activities, including the burning of midden refuse. Discoloration resulting from heating often precludes the determination of material type for cherts and chalcedonies, and had a limiting effect on the ability to visually source materials in the sample.



Figure 27: Discoloration of cherts resulting from thermal alteration (from Barrett 1999).

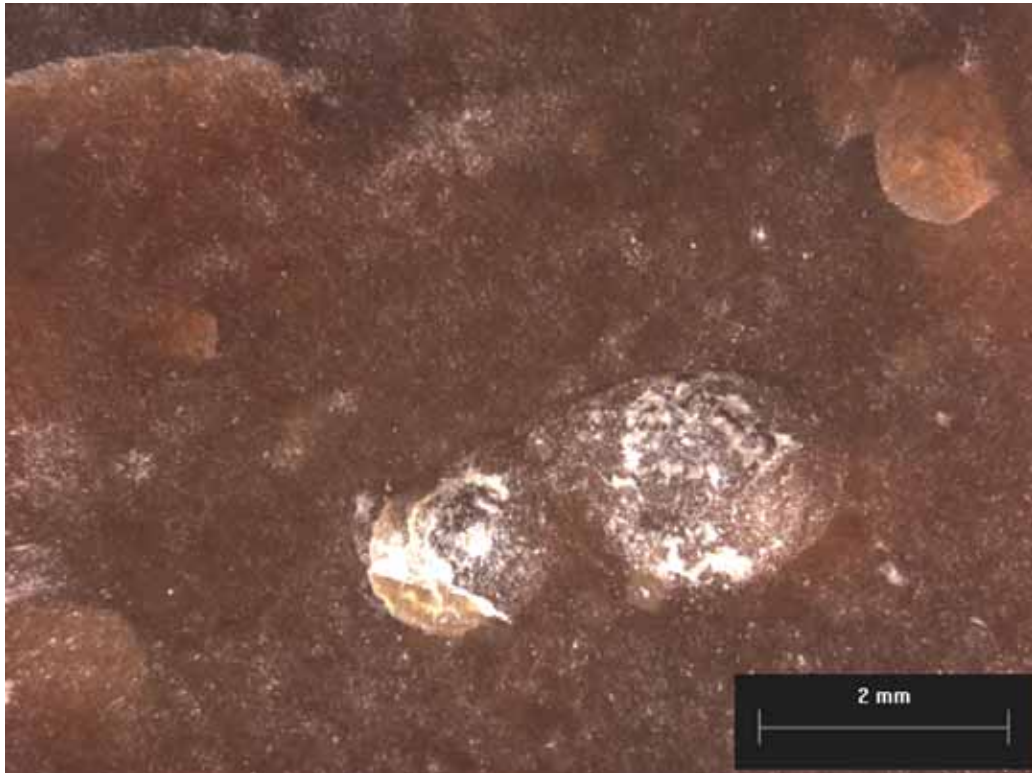


Figure 28: Crenellated fractures ("potlids") and crazing observed on the surface of a stone tool from Blue Creek.

The black appearance of some flaked stone artifacts caused speculation that a source of black chert may exist somewhere in Belize. However, the black appearance of these artifacts has since been shown to be the result of chemical weathering (Cackler, et al. 1999; Shafer and Hester 1990: 281). Black patinas have been found on chert artifacts recovered from riverine or lacustrine environments. This black discoloration is a weathering process often associated with cherts located in organically rich, reducing environments, stagnant and acidic water, or where cherts are in contact with humic substances (Luedtke 1992: 100; Shafer and Hester 1990: 281). Only two artifacts within the Blue Creek study sample exhibited a black patina.

Artifact Analysis

Evidence for stone tool production, use, and recycling can often be found by analyzing various features that are inherent to a lithic assemblage. Such analysis is essential for determining whether or not specific households or settlement groups within the Blue Creek polity differentially accessed and utilized lithic resources. Evidence of production is particularly relevant in assessing the capacity for direct raw material access, in contrast to acquiring finished goods through reciprocal gifting, intra-polity trade, or market exchange. Thus, assessing the stage of tool manufacture reflected within a debitage assemblage or by a particular tool form is a fundamental concern. Formal tool and debitage assemblages provide complementary information in this regard, though each data set can provide sufficient evidence for manufacturing, use and recycling patterns on its own. There is seldom any direct concordance observed between tool forms and debitage recovered within the same context, largely because of cultural patterns of resource use, activity organization, and waste disposal. Thus, the attributes of formal tool and debitage manufacture relevant to the assessment of manufacturing activity are discussed separately below.

Formal Tool Analyses

Manufacturing Stage

I used a linear reduction model to determine the manufacturing stage of each artifact (Figure 29). Linear reduction models provide a framework for understanding the functional and behavioral relationships among related sets of artifacts (Collins 1975; Shafer 1983, 1985; Sollberger 1977; Tsirk 1979), and are typically based on theoretical abstractions or on experimental replication (Crabtree 1966). Classifying tools in accordance with a linear reduction scheme allows for a more precise study of manufacturing concerns, and it provides a conceptual model for determining the degree of morphologic variation that finished trajectories may be expected to exhibit. The criteria for determining stage of manufacture used in this work closely follows that of Shafer (1985). I recognize five stages in the life cycle trajectory of tools in this work,

including: (1) initial production, (2) early stage shaping, (3) late stage forming and thinning, (4) finished products, and (5) rejuvenated forms. Admittedly, assessing manufacturing stage is not a wholly objective enterprise. The fragmentary nature of some artifacts, the retention of trace amounts of surface cortex on finished forms, and the absence of standardized production due to raw material variability and individual skill all contribute to the occasional difficulty in assigning production stage. However, as the criteria I used to assess manufacturing stage remained consistent throughout this study, I believe that the findings presented may be considered an objective reflection of variation within the sample. The greatest difficulty often involves distinguishing between early and late stage production forms (stages 2 and 3), and between finished and recycled tools (stages 4 and 5). Most tools, however, fit unambiguously into a single category.

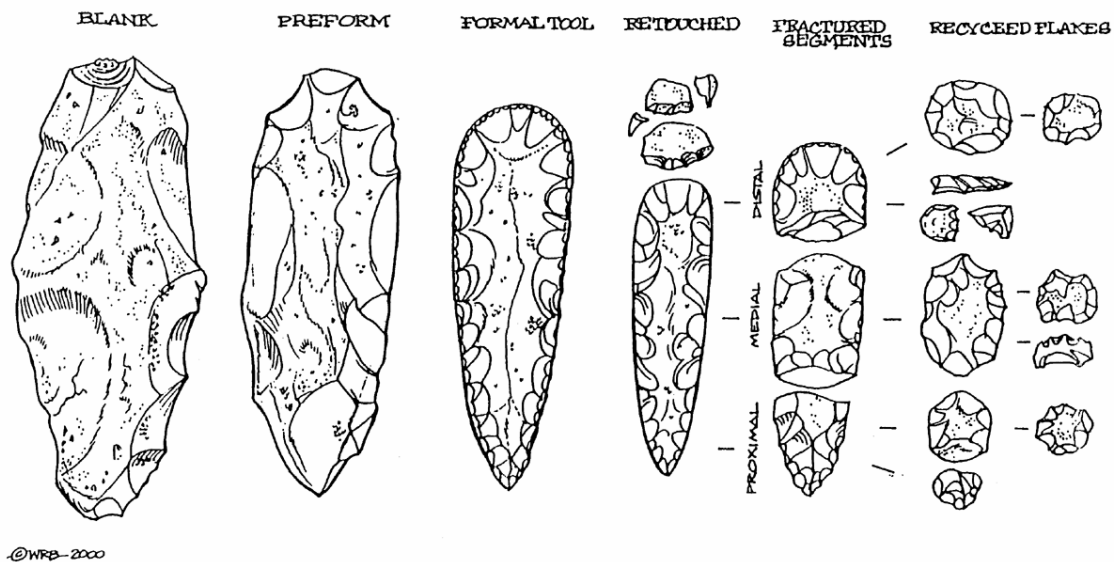


Figure 29: Linear reduction model showing the trajectory of a stone tool from the early stages of manufacture to resource exhaustion (drawing by Bill Bowman).

The first stage of the linear reduction model, *initial production*, indicates the beginning steps of tool manufacture and includes preliminary reduction efforts such as testing cobbles for material quality and removing cortex. At this stage artifacts typically exhibit unrefined edges and often retain cortex on their faces, if not their lateral margins. Tool forms in their initial production stage are invariably crude and do not provide an indication of the intended manufacturing trajectory. Such forms are often referred to as “blanks” (Crabtree 1972b). I morphologically classified artifacts abandoned after only a small amount of flake removals as worked cobbles.

The second category, *early stage shaping*, is characterized by the artisan’s initial commitment toward producing a singular or limited set of possible final trajectories, resulting in what is commonly called a “preform” (Crabtree 1972b). Tool forms in this stage of manufacture typically exhibit little if any cortex, though even complete tools may exhibit traces of cortex on occasion. Early stage production blanks often exhibit the general outline of the finished form, but generally require additional facial thinning and refinement of lateral surfaces.

The third category, *late forming and thinning*, is characterized by the artisan’s full commitment toward a specific morphological form. Artifacts categorized as late stage production forms -or “performs”- approximate their final design and generally lack only refinement of lateral edges and minor facial thinning. Cortex is rare on late stage forms.

The fourth category, *finished products*, includes artifacts that have reached the end stage of their manufacture. As these artifacts are fully functional; they presumably represent tools that were discarded (often due to breakage), cached, lost or abandoned. Finished forms require no additional production efforts, and often exhibit use-related edge modification.

The final category, *rejuvenated tools*, describes artifacts that exhibit pronounced edge retouch, a marked reduction in size, or evidence of secondary production in response to failure of the initial tool form. Tool rejuvenation and other forms of recycling provide important information regarding the perceived value of the resource.

Where material resources are scarce, recycling is much more common and more thorough (McAnany 1989b; Shafer 1983). At Blue Creek, patterns of recycling may also reflect the limitations of resource use-rights.

Secondary Use

Many tools in the Blue Creek assemblage exhibit evidence of having been recycled. In instances where an initial functional design (such as a celtiform biface) is overlaid by a secondary use pattern (such as hammerstone), I recorded both the primary and secondary forms. Many tools displayed evidence for having functioned secondarily as hammerstones, while others served as edge abraders and flake cores, or were fashioned into informal bifaces or unifaces, gravers, drills, or scrapers. The most frequently observed secondary use pattern was hammer-wear, which occurred on 2.8% (n=59) of artifacts. Secondary use often involves complete remodeling of the tool form (Rots 2003). In many such instances, the original form and use of the tool cannot be determined, and I recorded the final form of the tool as its primary form.

Discard and/or Failure

Determining the reason why a particular tool form was discarded is seldom a straightforward endeavor. Oftentimes such a determination cannot be made at all. However, where a cause of discard can be determined, valuable insights regarding production specialization and standardization, raw material conservation, use context, and cultural ideology may be gleaned (Michaels 1987; Roemer 1984). Production may be aborted and tool forms may be discarded during manufacture due to any one of a number of technical or material deficiencies (Figure 30). Tool forms may also be discarded due to failure during use, which carries implications for the likelihood of their recovery. Archaeological excavations tend to focus on the remains of architecture, a methodology poorly designed to recover artifacts from agricultural fields, drainage canals, and other between-space areas. Tools may also be ritually deposited in

architectural and sub-floor caches or burials. Alternately, tools may be rigorously recycled, alluding to the scarcity and value of raw materials.

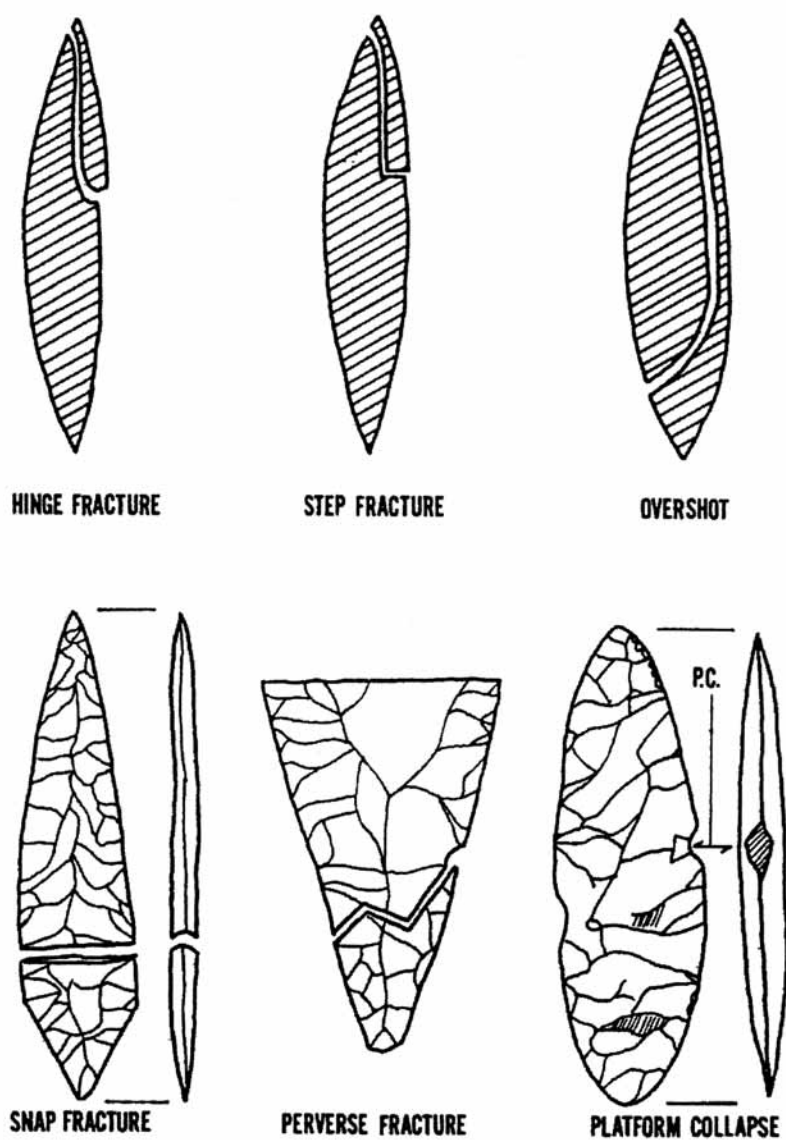


Figure 30: Forms of production failure (after Michaels 1987, Fig. 33).

Heat fractures often presented an obstacle for assessing the probable cause of original discard. Many artifacts appear to have been subjected to excessive heat following their discard. This could relate to their incorporation into refuse middens or ritually terminated deposits, or, alternately, could be the incidental effect of modern or ancient surface fires. Burning of the vegetation on large areas of land is a common practice in the Blue Creek region today as modern farmers seek to claim the landscape for rice cultivation or cattle pastures. As a result, deposits at or near the surface are often burnt. This was in fact the case in several of my own excavations. Swidden cultivation practiced in antiquity would have had the same destructive effect of shallow, subsurface deposits. The over-firing of raw material blanks or, possibly, preforms may also have contributed to the number of fire-damaged artifacts recovered. Secondary tool modification and material re-use also complicated determinations of failure, as did patina development.

When more than one failure trait was expressed in an artifact, I recorded the most significant cause for failure. For example, if a snap fracture resulted during production due to a fossil or crystalline quartz inclusion within the material, I recorded material flaw as the cause of failure. In conjunction with other features of the assemblage, this information may potentially reveal patterns of raw material use vis-à-vis preference with respect to a given tool form, specific considerations knappers observed in choosing raw materials for stone tool production, correlations between tool form and failure patterning, and temporal changes in material procurement patterns.

Several authors have previously described snap or bending fractures (Crabtree 1972:60; Whittaker 1994:213; and Tsirk 1979:84). This fracture results when the lithic material is subjected to bending forces that exceed the material's elastic limits. Snap fractures often occur during tool production due to the knapper's failure to provide the preform with adequate support as it is reduced. In so doing, vibrations radiate throughout the tool form with each percussive strike, causing a fracture at the point where the elasticity of the material can no longer absorb the vibrations (Whittaker 1994: 213). Bending fractures can also occur quite commonly as the result of tool use. Use-

derived bending fractures manifest as lateral truncations that often display a rolled or lipped edge along one side of the termination (Shafer 1985: 283). When a rolled lip is observed, it may indicate that the tool was subjected to excessive torque during use, and the lip invariably appears to terminate at the hafting element. Snap fractures may also derive from material flaws, such as cavities or crystalline inclusions, which cause disharmony in the radiation of percussion waves through the material, or simply produce areas of weak structural integrity. I recorded snap or bending fracture as the primary cause of discard for 42.5% (n=903) of the Blue Creek study sample.

Step and hinge fractures present analogous difficulties for tool production or recycling, and are formed through similar circumstances. Thus, I treat them as a single category of failure in this study. Step fractures occur when percussion force wanes as it travels through a material, causing the premature truncation of the flake (Crabtree 1972: 92; Whittaker 1994: 109). Step fractures are similar to snap fractures with regard to the fracture mechanics of brittle solids in that they result in the truncation of material due to the unchanneled dispersion of percussive force. Similarly, hinge fractures occur when inadequate percussive force is applied to reduction efforts, preventing the flake from traveling the desired distance (Whittaker 1994: 109). However, rather than the flake being prematurely truncated as in step fractures, hinge fractures result in the full termination of the flake, although this termination occurs earlier than the intended point of egress. This produces a rounded or blunt break and a disproportionate distribution of material mass that impedes further reduction efforts (Crabtree 1972: 68). With either step or hinge fractures, a mass of material is left in the medial area of the core, preform, or tool which is greater than the original fracture plane of the subsequent flakes that are initiated to reduce that area. Further reduction efforts often produce stacked step fractures or continued hinging, resulting in the knapper's inability to further reduce medial areas or to rejuvenate worn-out tool forms (Whittaker 1994: 109). Although they are morphologically dissimilar, the causes of hinge and step fractures, as well as the ensuing impediments for material reduction, are nearly equivalent (Whittaker 1994: 109). Step and hinge fractures often occur in the production of stone tools, but may also

occur through tool use. Flakes may be inadvertently removed when tools come into contact with other materials as they are used in various tasks. Regardless of the trajectory stage, step and hinge fracture present a challenge to future reduction efforts, and may necessarily result in the objects discard. I recorded step or hinge fractures as the primary cause of discard for 4.3% (n=92) of the Blue Creek study sample.

Failure and discard may also occur during reduction and rejuvenation efforts as the result of platform loss. The loss or collapse of a workable striking platform is often the consequence of improper reduction techniques or unanticipated fractures that leave no viable surface on which to strike and remove a desirable flake. Platform loss typically occurs during efforts to remove excessive mass from the medial areas of cores, preforms, and recycled tools, and may result in the inability to remove a desired mass without compromising the dimensional requirements of the desired trajectory. I recorded platform loss as the primary cause of discard for 1.9% (n=41) of the Blue Creek study sample.

I recorded material flaw as the motivation for discard in 3.1% (n=66) of all formal tools. Material flaws typically manifest as mineral inclusions or cavities that differ compositionally from the matrix material, and produce anomalous fractures during production, or preclude further reduction efforts (Figure 31). Inclusions that I observed in the Blue Creek assemblage were typically either macrocrystalline quartz or fossil inclusions, though most material flaws were the result of solution cavities.

Overshot (*outrépassé*) failures occurred very infrequently within the Blue Creek assemblage (0.2%, n=4). Shafer (1985: 285) has described this fracture as a thinning fracture that is produced when the “flake’s trajectory dips and removes much of the opposite edge with distal termination.” Failures of this type are most frequently observed during production, but may also occur during rejuvenation efforts. Overshot failures generally result from the application of excessive percussion force.

Perverse fractures, as defined by Crabtree (1972b: 82), are a spiral or twisting break that initiates at the point of percussion and follows through the object, causing its segmentation. Though infrequently, I also noted perverse fractures in the Blue Creek

study sample; I observed them on 0.7% (n=14) of the artifacts analyzed. Perverse fractures typically occur during tool manufacture, but occasionally seem to result from excessive torque during use.



Figure 31: Material flaws observed on tool forms recovered in excavations at Blue Creek and Sotohob.

A significant number of artifacts appear to have been discarded after being subjected to excessive heat (9.2%, n=195). I noted crenellated fractures, which are irregular pitted scars resulting from heating of the lithic material (see Figure 28), on the majority of artifacts that I recorded as heat failures. Other heat failures exhibited crazing and spall fractures. Both crazing and spalling occur due to the differential expansion and contraction of material that accompanies uncontrolled heating and cooling. Lithic material expands as it heats. When heated too quickly, particulate inclusions may expand more rapidly than their matrix causing “potlid” or crenellated fractures. When materials cool too quickly, the rapid cooling of the exterior may cause it to contract and separate from the slower cooling, still expanded core, thus producing crazing and spalling. Much like evaluating firing with regard to material alteration, firing fractures are of dubious origin. Fractures on finished forms are more likely to be the result of tools having been exposed to midden fires following discard. Fractures of cores and preforms may yield the greatest evidence for the deliberate firing of raw materials for the purpose of altering their mechanical properties. Because post-depositional firing and modern disturbance must also be considered, the cause of material alteration cannot be determined without considering the artifact’s context of deposition and context of recovery. Whittaker (1994: 73) points out that firing is most successful when cores are well into their developmental trajectory, prior to final flaking.

Based on the analysis of flakes recovered from the workshop deposit that I excavated in the Dumbbell Bajo settlement zone, near the site of Bedrock, it appears that intentional heat treatment followed initial cobble reduction (during phase 2, and less commonly phase 3, of the trajectory system used in this study) in the case of *bajo* chalcedonies. Denser, more coarse-grained quartzites and dolomites may have been heat treated prior to initial reduction. This contrasts the production of tools from fine-grained cherts, that are only infrequently heat treated. While heat treatment may increase the utility of a raw material, making it more amenable to reduction efforts, the process also weakens the material, making it more fragile. Heat treatment is also a costly process in terms of energy expenditure and the likelihood of resource loss due to over-firing.

However, the benefits of heat treating raw materials outweigh the disadvantages where natural resource utility is low, and the process is indeed a necessary part of converting resources for human use.

The probable reason for the discard of many tool forms in the Blue Creek sample was material exhaustion. Forms were considered exhausted at the point where they offered no further practical utility, which is to say that they could not be recycled into a secondary tool form through further reduction. This determination was based on an assessment of remaining mass, raw material properties, and the presence of inhibitive fractures. I recorded material exhaustion as the primary cause of discard for approximately 31% (n=653) of the Blue Creek study sample.

Morphology

An important consideration in the study of formal tools is morphological classification as it represents the primary basis for comparison among archaeological assemblages. The greatest difficulty confronting the systematic comparison of lowland lithic artifact assemblages is the lack of a consistent, agreed-upon descriptive classification system (Moholy-Nagy 1991). Taxonomic descriptions applied to formal tools in the Maya lowlands are particularly idiosyncratic. Maya tool forms tend to be named according to morphologically descriptive, technological, or functional properties. Ideally, only one of these descriptive systems should be employed. However, the selection of a single system is complicated due to the advantages and disadvantages inherent to each system, and is ultimately undermined by the continued application of well-entrenched terminology. Morphological typologies present a neutral means by which to describe artifacts without interjecting unwarranted functional interpretations. However, such descriptions may be overly similar between tools whose form varies more in scale than in actual design. Several different tools, for example, may be classified as oval bifaces. Descriptive labels may also become cumbersome in their attempts to draw distinctions between morphologically similar tool types. A tool typology based strictly on technological properties is well suited for describing artifacts

with fairly unique production characteristics (such as tranchet-bit tools), but they distinguish few differences between tools with similar modes of manufacture. Finally, functional descriptions are too often based on presumed rather than demonstrated function. Also, they may separate ostensibly identical tool forms into different types based on variation in use-wear, ignoring the multi-functional nature of the form. Many tool forms were certainly multi-function tools, and in such cases, the pattern of use may have been determined by the immediate needs of the user rather than wholly ascribed by the attributes of the tool form.

The descriptive labels that I have applied to tool forms within this analysis generally embrace previously established terminology (Table 2). While using these established classes has the disadvantage of employing terminology without a standardized basis for categorization (with terms based on behavioral, technological, morphologic characteristics), it offers the advantage of broad recognition. Formal morphological classes employed here are in common use throughout the Maya lowlands and are well represented in published sources (Gibson 1986; Hester 1985; Rovner, et al. 1997). I have chosen to employ unique labels only in distinguishing previously unreported artifact classes, to allay confusion caused by redundant or ambiguous terminology, and to avoid overly prescriptive functional labels.

Portion

A significant number of tools were recovered in a fragmentary state. When possible, I recorded the represented portion of the tool. I identified many partial tools as proximal, distal, or medial segments. Other partial tools were represented by biface tips, lateral margins, and indeterminate fragments. I identified partial forms as “fragments” when too little of the tool remained to speculate what part of the tool it may represent. Given the bipolar symmetry inherent to some forms, it was occasionally difficult to determine whether a piece corresponded to a proximal or distal segment, even when it was clear that one or the other was represented. In such instances, I recorded the artifact

portion as “undeterminate.” I used only complete tool forms in either finished or late stage production phases for metric calculations of average tool proportions.

Table 2: Descriptive terminology used to classify various stone tool types in the Maya Lowlands.

TYPE	PUBLISHED REFERENCES	PERIOD	PUBLISHED DESCRIPTION
Celtiform Biface [ovate]	1. Coe 1959: Fig. 1 2. Kidder 1947: Fig. 61c-k 3. Ricketson 1937: Pl. 54b 4. Willey et al. 1965: 426 5. Rovner and Lewenstein 1997: Fig. 8 6. Anderson 1982: 166 7. Shafer and Hester 1996: 7 8. Aldenderfer et al. 1989	1. ? (surface) 2. ? 3. ? 4. Classic-EP 5. EC – EP 6. ? 7. EP 8. Classic	1. Chopper 2. Chopping tool 3. Chopping tool 4. Standard chopper 5. Cordiform 6. Chopper 7. Elongated biface celts 8. General utility biface
Celtiform Biface [rectilinear]	1. Kidder 1947: Fig. 61n-o 2. Willey 1972: 179 3. Willey et al. 1965: Fig. 270h-m 4. Gibson 1986: 142, 149 5. Hester, Shafer, and Berry 1991: Fig. 2f-g	1. ? 2. LC - ? 3. LC 4. LC – EPC 5. GP	1. Pecking and pounding tools 2. Adze 3. Bifacial adz or plane 4. Narrowed celt, rectangular hoe 5. Bifacial celt
Large Oval Biface Celt	1. Shafer and Hester 1983: 524, Fig. 7 2. Shafer 1985: 298-302, Fig. 12b 3. Hester and Shafer 1994: Fig. 15 4. Gibson 1986: 114	1. LPC 2. LPC 3. LPC 4. LPC	1. Large oval biface 2. Oval biface 3. Large oval biface 4. Large oval biface
General Utility Biface	1. Ricketson 1937: Pl. 56a-2 2. Willey et al. 1965: Fig. 273f 3. Shafer and Hester 1983: Fig. 8e 4. Hester and Shafer 1994: Fig. 19a 5. Gibson 1986: 140	1. ? 2. LPC – LC 3. LC 4. LC – TC 5. LC	1. Turtle-back axe 2. Chopper or general utility tool 3. Truncated base biface celt 4. General utility biface 5. General utility biface
Stemmed Macro-blade	1. Ricketson 1937 2. Willey et al. 1965: Figs. 264a-b, 265b-c, 266 3. Moholy-Nagy 1991: 196-198 4. Shafer and Hester 1983: 524 5. Hester and Shafer 1994: Figs. 17, 23-24 6. Hester, Shafer, and Berry 1991: Figs. 5-8	1. ? 2. EC 3. LPC 4. LPC 5. LPC 6. LPC-EC	1. Flint dagger 2. Unifacial plano-convex stemmed point or dagger 3. Tanged macroblade 4. Stemmed macroblade 5. Stemmed macroblade 6. Stemmed macroblade
Stemmed Blade	1. Ricketson 1937: Pl. 61 b-14 2. Shafer and Hester 1983: Fig. 8d 3. Hester and Shafer 1994: Fig. 19b-d 4. Gibson 1986: 146 5. Roemer 1984: 139-183	1. ? 2. LC 3. LC – TC 4. LC – TC 5. LC	1. Flint dagger 2. Stemmed blade 3. Stemmed blade point 4. Stemmed blade 5. Blades

LPC=Late Preclassic; EC=Early Classic; LC=Late Classic; TC=Terminal Classic; EP=Early Postclassic; MP=Middle Postclassic; LP=Late Postclassic; GP=General Postclassic.

Table 2. Continued

TYPE	PUBLISHED REFERENCES	PERIOD	DESCRIPTION
Postclassic Arrow Point	<ol style="list-style-type: none"> 1. Proskouriakoff 1962: Fig. 35c, e-g 2. Rovner and Lewenstein 1997: Fig. 15f-k 3. Andreson 1979: 163, Fig. 8 4. Gibson 1986: 151 	<ol style="list-style-type: none"> 1. GP 2. LC 3. LP 4. LP 	<ol style="list-style-type: none"> 1. Arrow points (side notched with or without notched bases) 2. Side-notched points-on-blade 3. Side-notched arrow points 4. Basal and side-notched arrow points
Side-notched Dart Point [EPC]	<ol style="list-style-type: none"> 1. Kidder 1947: Fig. 63 2. Willey 1972 3. Moholy-Nahy 1991: 198 4. Proskouriakoff 1962: Fig. 30b-c 5. Shafer and Hester 1983: Fig. 10c-d 6. Hester and Shafer 1994: Fig. 22a 7. Gibson 1986: 150 	<ol style="list-style-type: none"> 1. GP 2. TC – EP 3. LC 4. GP 5. EP 6. EP 7. EP 	<ol style="list-style-type: none"> 1. Expanded stem flint points 2. Expanded stem, - long blade 3. Small points 4. Side notched with straight or rounded base 5. Side-notched dart point 6. Side-notched point 7. Side-notched projectile point
Lenticular Biface	<ol style="list-style-type: none"> 1. Coe 1959: Figs. 3, 19, 20 2. Kidder 1947: Fig. 68c-d 3. Ricketson 1937: Pl. 54a 4. Willey 1972: 174 5. Willey et al. 1965: 412 6. Proskouriakoff 1962: Fig. 28 7. Rovner and Lewenstein 1997: Figs. 10a, 11a-b, 13 l-m 8. Shafer and Hester 1983 9. Hester and Shafer 1994: Fig. 22b 10. Shafer 1985: 289-292 11. Gibson 1986: 129, 148 	<ol style="list-style-type: none"> 1. EC – TC 2. EC – TC 3. EC – TC 4. LC - ? 5. TC - ? 6. LP 7. LC 8. EP 9. EP 10. EP 11. EC-EP 	<ol style="list-style-type: none"> 1. Knife or projectile point 2. Unstemmed projectile point, Laurel Leaf blades 3. Scraper knives 4. Bi-pointed knives 5. Laurel Leaf unstemmed bifacial blades 6. Long knives, sacrificial knives 7. Bifacial dagger, short-sword, simple biface 8. Laurel Leaf biface 9. Lozenge-shaped point 10. Laurel Leaf biface 11. Laurel Leaf biface, lenticular biface
Triangular Biface	<ol style="list-style-type: none"> 1. Proskouriakoff 1962: Fig. 31 2. Shafer 1985: 286-289, Figs. 6f-h, 12 3. Gibson 1986: 152 4. Michaels 1987: 153, Fig. 30 	<ol style="list-style-type: none"> 1. MP – LP 2. EP 3. EP 4. EP 	<ol style="list-style-type: none"> 1. Hatchet-form flints 2. Triangular biface 3. Triangular adz 4. Triangular adz
Bit Adz-like Biface	<ol style="list-style-type: none"> 1. Kidder 1947: Fig. 78l, p 2. Proskouriakoff 1962: Fig. 24 	<ol style="list-style-type: none"> 1. ? 2. GP 	<ol style="list-style-type: none"> 1. Celt 2. Polished celt

LPC=Late Preclassic; EC=Early Classic; LC=Late Classic; TC=Terminal Classic; EP=Early Postclassic; MP=Middle Postclassic; LP=Late Postclassic; GP=General Postclassic.

Edge Modification

Assessing the way in which a stone tool was used is an important aspect of lithic analysis, and one often plagued by ambiguity. Early analyses in Mesoamerica tended to draw direct correlations between form and function. These untested assertions were often based on cross-cultural analogies that have proven inadequate for a variety of reasons. One of the most significant obstacles to a direct analogical approach is the multifunctional nature of many Maya tool forms. Careful examination of use-wear has shown that specific tool forms were utilized for multiple tasks, with wear patterns showing marked variability. Dockall and Shafer (1993) have shown that the use of stemmed macroblades varied substantially within and between sites. Similarly, Shafer and Hester (1990) have described the variable use-wear patterns observed on celtiform bifaces. Function cannot be easily assumed based simply on tool morphology, but must be assessed through detailed observation of wear patterns left on tools.

I recorded four separate qualities of edge modification and their associated patterns of distribution for the tool forms in the Blue Creek study sample. These included flaking, crushing or smoothing, polish, and etching or pitting. The co-occurrence of use-wear patterns was frequently observed, and the coding system that I used has been designed to record of all observable traces of wear.

The class of wear patterning labeled “flaking” included instances of edge attrition that allude to direction and form of use, type and relative strength of contact material, and desired edge of contact (Odell and Odel-Vereecken 1980) (Figure 32). Odell and others (1980:98-100) classify marginal attrition according to the form of flake terminations and their placement on the tool in their analysis of an experimental assemblage using low-power magnification. This data is then correlated to the activity performed with the tool that was responsible for generating the particular pattern of wear. However, using the findings from such studies without accounting for cultural and environmental context is problematic. The actual function of ancient tools in their cultural context cannot generally be determined unequivocally, largely stemming from the fact that various tasks have been shown to produce similar wear patterns (Lewenstein

and Walker 1984). The relationship between tool function and edge wear is not entirely understood, particularly with regard to the development of polish. While the pattern of use may be usefully addressed with low-power microscopy, identification of contact material generally requires the use of more powerful analytical techniques such as scanning electron microscopy (SEM) in combination with an extensive comparative data set. Thus, I made no such functional determinations for the Blue Creek assemblage. My analysis of edge attritions was limited to identifying its generalized form and pattern of occurrence. I recorded marginal attrition as distal, distal lateral, unifacial-unilateral, unifacial-bilateral, bilateral-bifacial, circumferential, primary-proximal, secondary proximal, or not present (Figure 33).

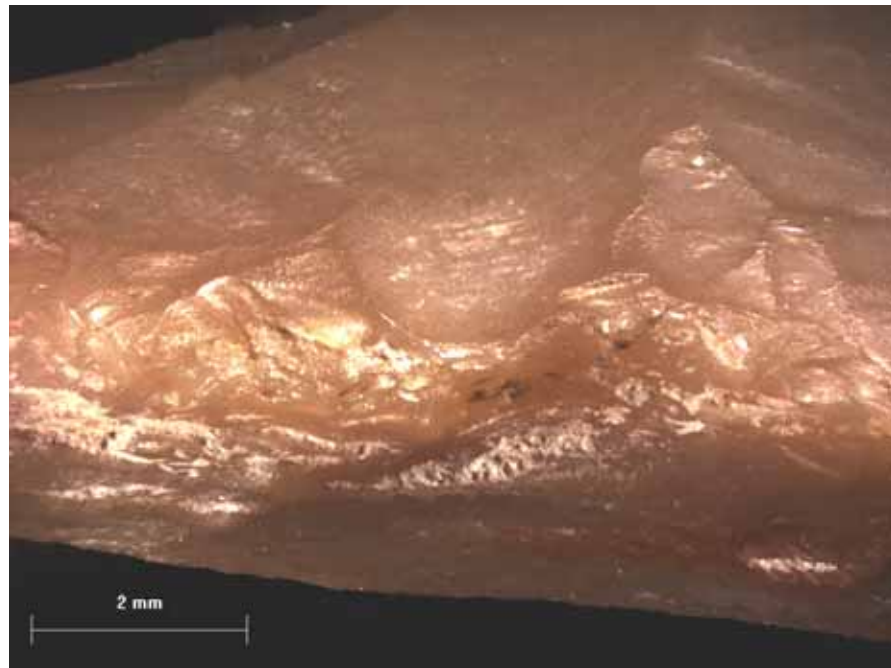
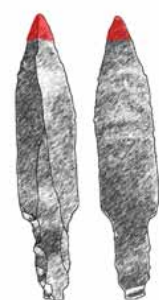


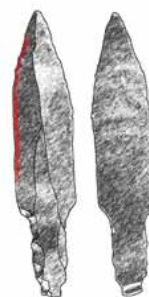
Figure 32: Bilateral bifacial flaking observed along the distal margin of a bifacial tool form. A Leica MZ12₅ (12.8 – 160.0 X) light microscope was used to obtain all images of use-wear in the Center for the Study of the First Americans microscopy laboratory at Texas A&M University. Images were captured using *Image-Pro Plus* (version 4.5.1), and *In-Focus* (V.1-60) was used to create final images with an extended depth of field.



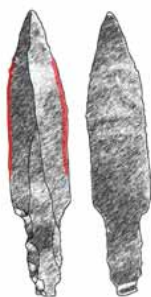
Distal Use Wear



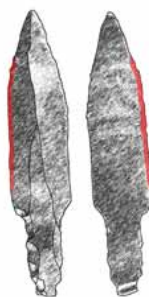
**Distal-lateral
Use Wear**



**Unilateral-unifacial
Use Wear**



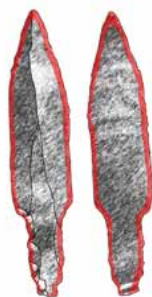
**Bilateral-unifacial
Use Wear**



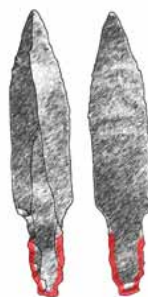
**Unilateral-bifacial
Use Wear**



**Bilateral-bifacial
use Wear**



**Circumferential
Use-wear**



Proximal Use-wear

Figure 33: Patterns of "flaking" attrition recorded for formal stone tools at Blue Creek.

Edge modification is not always the product of material use. Other taphonomic processes, such as trampling, have been shown to produce edge modification similar to that developed through actual use (McBrearty, et al. 1998; Shea and Klenck 1993; Tringham, et al. 1974). Such taphonomic processes obviously affect the recognition of some patterns of wear more than others. Distinguishing use-derived flake terminations along the lateral margins of tools is perhaps the most equivocal functional assessment, although Odell et al. (1980) state that the patternlessness of such incidental attrition is detectable and, thus, can be distinguished from actual use-wear with a high level of accuracy. While tools may derive a form of polish in deflationary zones due to aeolian processes, and may derive edge battering in fluvial deposits, neither process is a significant concern in northwestern Belize. Given the possibility of their emanation from trampling or other taphonomic processes, I only recorded artifacts on which such terminations exhibited worn or polished facets as exhibiting “flaking” use wear. While this undoubtedly underestimates the actual amount of use-wear exhibited throughout the assemblage, it substantially increases the accuracy with which positive determinations were made.

I use the use-wear category “crushing or smoothing” was used to describe the form of wear attained through battering, grinding, or polishing. The tool is typically blunted through battering or abrasion against a hard contact material in the process of use (Figure 34). Crushed working surfaces may be a desired and cultivated trait, such as with hammerstones, or they may be an undesired consequence of use and material attrition that necessitates edge resharpening. Smoothing is typically the result of intensive abrasion and is commonly observed on tools used for grinding, polishing, or burnishing. When I observed it, I recorded crushing or smoothing as distal, distal-lateral, unilateral, bilateral, facial, facet, circumferential, primary proximal, or secondary proximal (Figure 35). In the case of hammerstones, the distribution of wear is often circumferential. Hafted bifaces more commonly exhibit crushing distally or along one lateral margin. Stucco floor polishers exhibit unifacial or bifacial smoothing, whereas

small, wedge-shaped polishing stones (or burnishing stones) typically exhibit facet smoothing.



Figure 34: Edge-crushing observed along the lateral margin of a bifacial tool form used as a percussor.

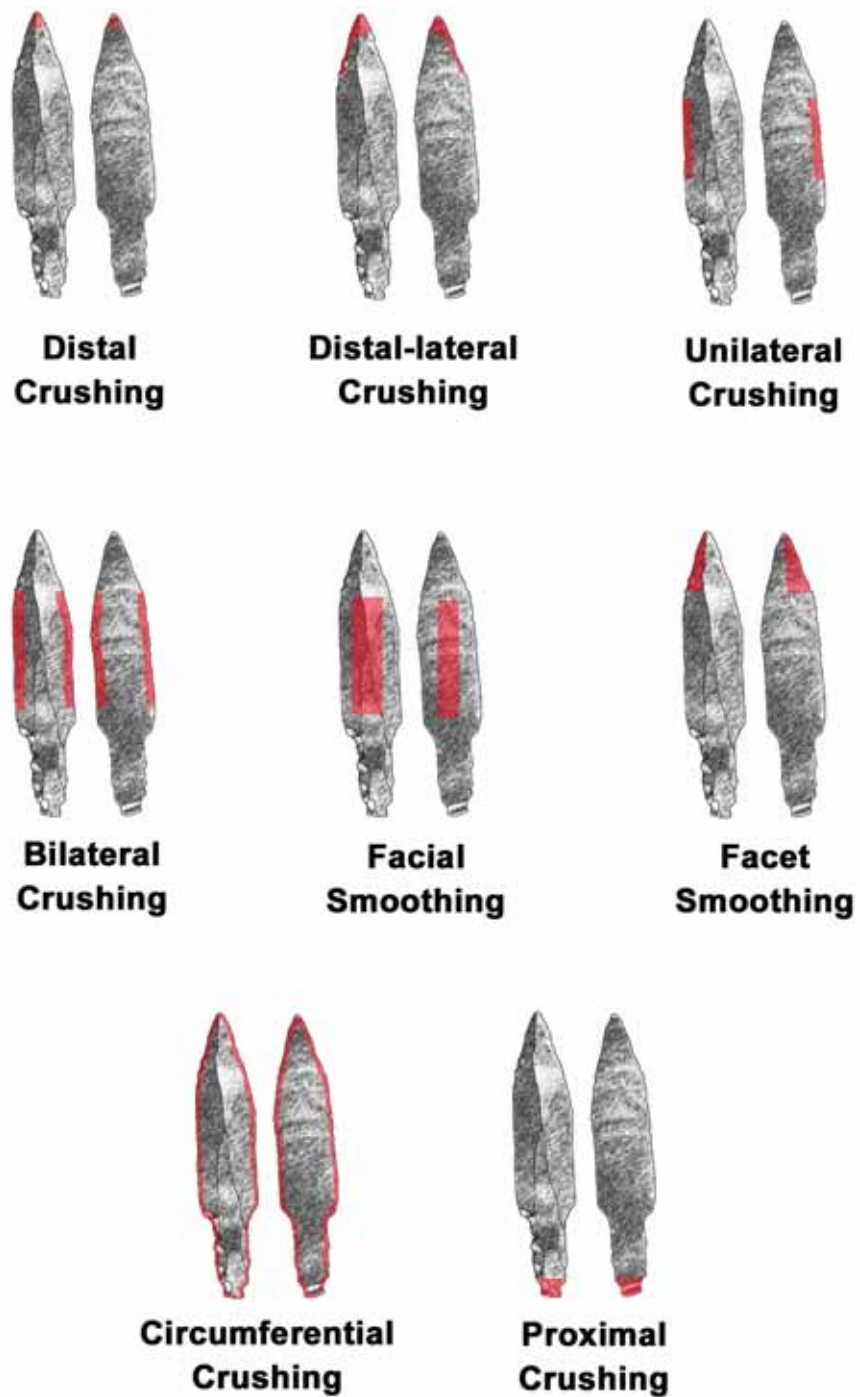


Figure 35: Patterns of "crushing" and "smoothing" attrition recorded for formal stone tools at Blue Creek.

I employ the use-wear category “polish” to describe lustrous areas on the tool, typically located at distal or lateral margins, but I occasionally noted it on medial surfaces (Figure 36). When I observed it, I recorded polish as shallow distal, deep distal, shallow lateral, deep lateral, unifacial medial, bifacial medial, distal-medial, hafting, bipolar, or proximal (Figure 37). Polishes were recorded as shallow when restricted to within 5mm of an edge. Polishes were defined as deep when they extending up to 20mm from their edge of origin, while those extending beyond 20mm were defined as distal-medial polishes. I defined polishes that were detected on medial surfaces, and which often wrapped around the artifact or were associated with worn, ground, or otherwise blunted lateral margins, as hafting polishes. The presence or absence of a use-derived polish could not be determined in many instances due to the effects of fire alteration. In extreme cases, lithic material became vitrified through over-exposure to heat, which produced a lustrous sheen that covered the surface of the artifact. Polish derived from use was occasionally difficult to differentiate from the luster that develops from specialized manufacturing techniques. Ground and polished surfaces are seen on round-bit celtiforms, chisel-forms, and ground-bit adze-forms (Appendix A), however this luster is not use-derived, but is rather the product of the extensive grinding required to produce the form. Only rarely was I able to differentiate use-derived polish from production-derived polish on ground and polished tool forms macroscopically.

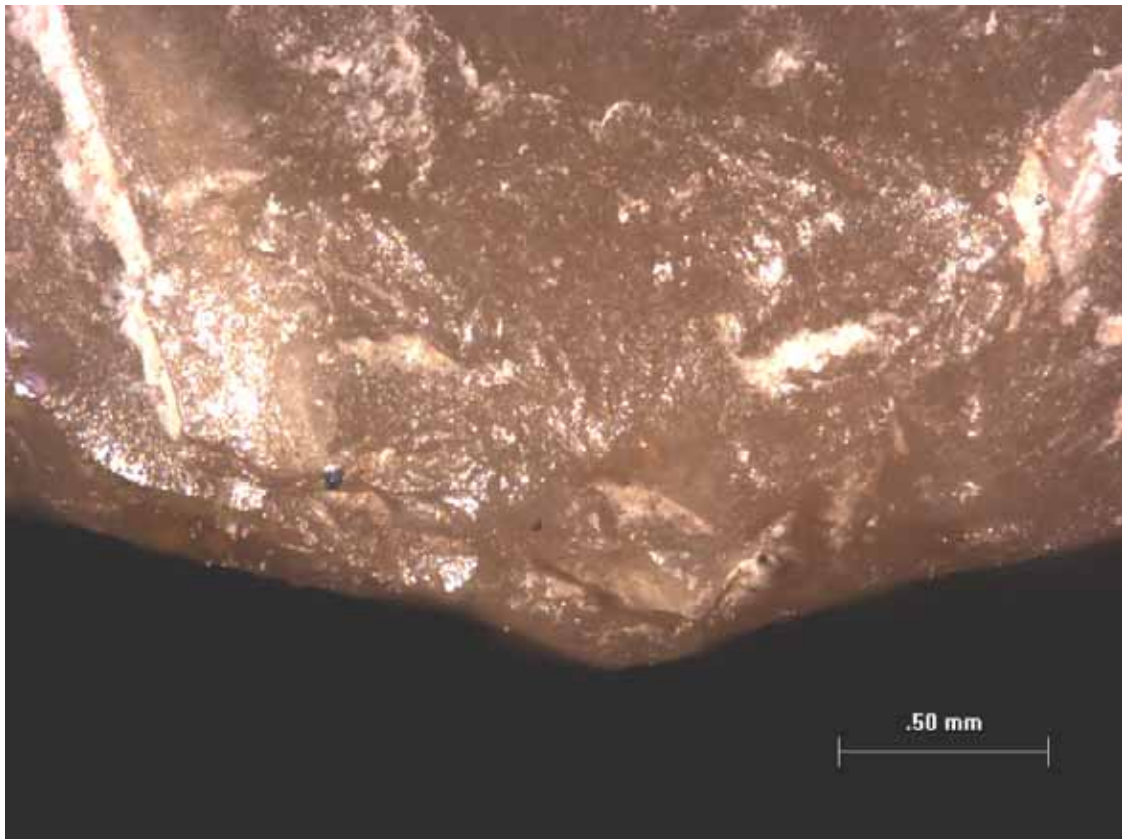


Figure 36: The polished and rounded lateral margin of a bifacial tool form recovered in excavations at Blue Creek.

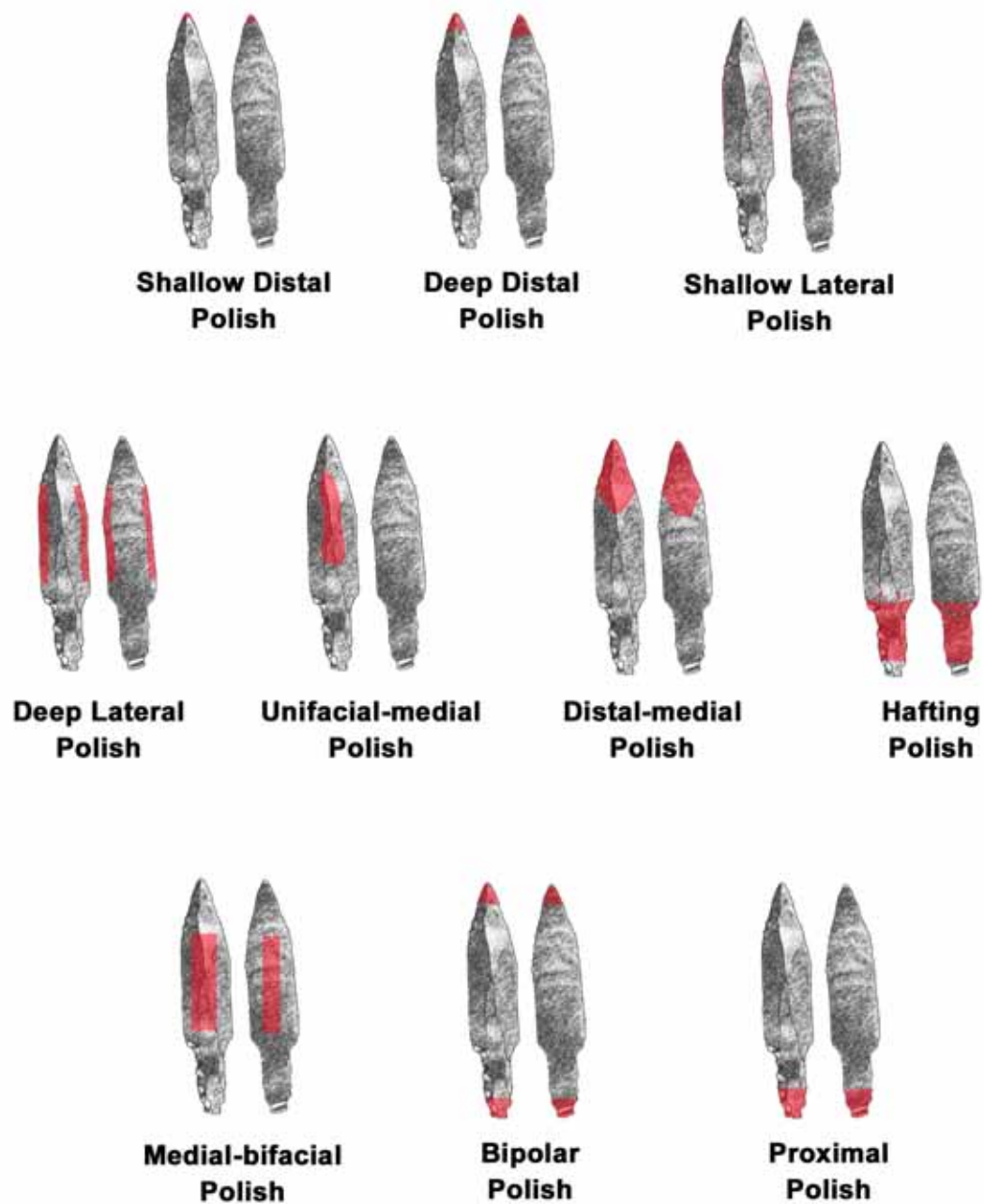


Figure 37: Patterns of polish distribution recorded for formal stone tools at Blue Creek

The origin of polish is not well understood despite having been the subject of generous scholarly attention (Odell 2001). Research into the nature of use-polish is generally focused either on the patterns of polish formed on stone tools as the result of a specific set of activities (cf. Aoyama 1999; Keeley 1977, 1980; Semenov 1964), or on the genesis and composition of polish itself (Fullagar 1991; Grace 1996; Odell 2001). In controlled studies where tool forms were utilized in a defined set of prescribed behaviors, researchers have had notable success in correlating patterns of use-polish with the specific activities that generated them (Aoyama 1999; Clark 1988; Lewenstein 1987). However, studies have also shown that a diverse set of activities may produce virtually identical patterns of use-polish (Lewenstein and Walker 1984). Researchers have also found that multifunctional tools generally preclude the correlation of specific tasks with specific patterns of polish (Clark 1988). It is perhaps best to consider that the form of the tool, the raw material used in its manufacture, and the patterns of wear (in any form) seen on it will provide a range of functional possibilities and limitations for how it was used in a particular cultural and techno-environmental setting.

I use the use-wear category “etching or pitting” to describe striations produced through abrasive contact (Semenov 1964). As with polish, such stria may occasionally derive from production techniques, although this is generally only a concern for tool forms featuring ground bits. Etching is better studied microscopically. The macroscopic techniques used in this study were useful for detecting the moderate to deep scarring that is characteristic of working soils with a significant sand content, but they may have missed evidence left from working the clayey soils of the area’s *bajos*. Striations typically emanate from the distal margin of the tool (Figure 38), and the extent to which they cover the face of a tool form often provides some indication of how far the tool had penetrated the contact material. Striations may be created through quarrying, soil working, planing, polishing, or grinding. Figure 39 illustrates the patterns of etching and pitting that I recorded in analyzing formal tools at Blue Creek.

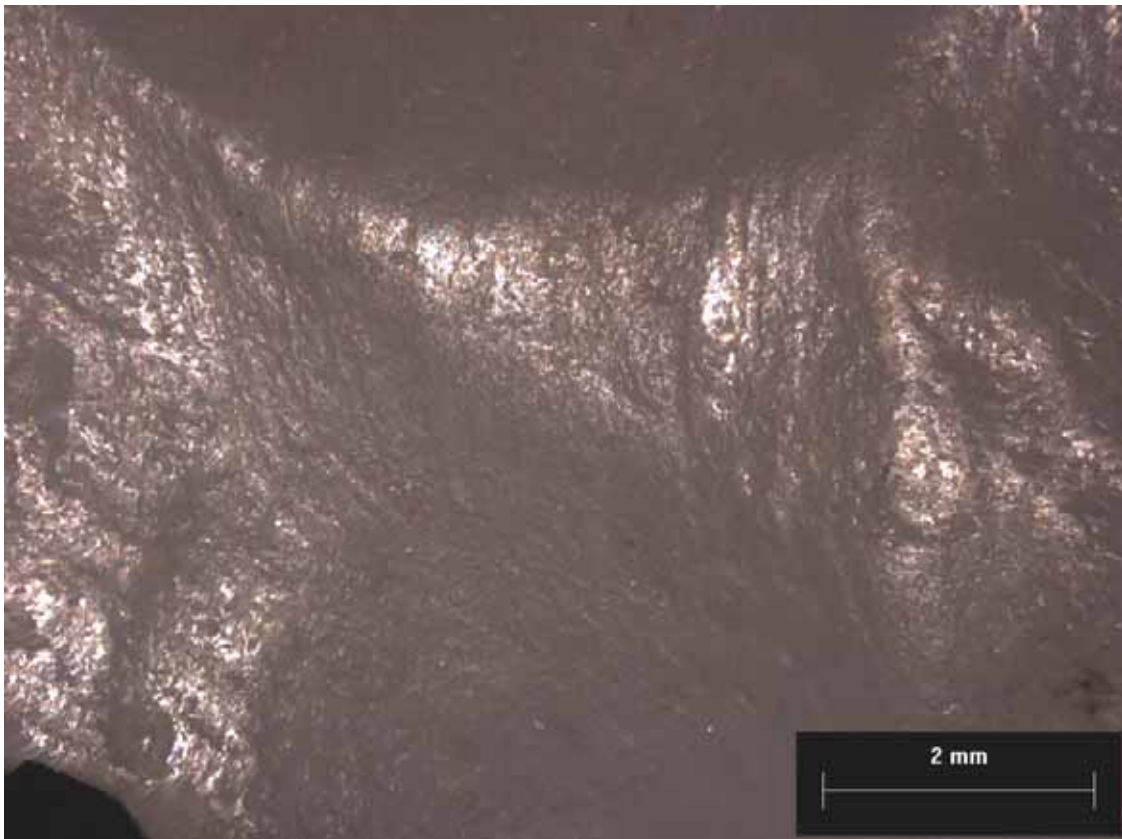


Figure 38: Stria running transverse to the distal margin of a celtiform biface recovered in excavation at Blue Creek.

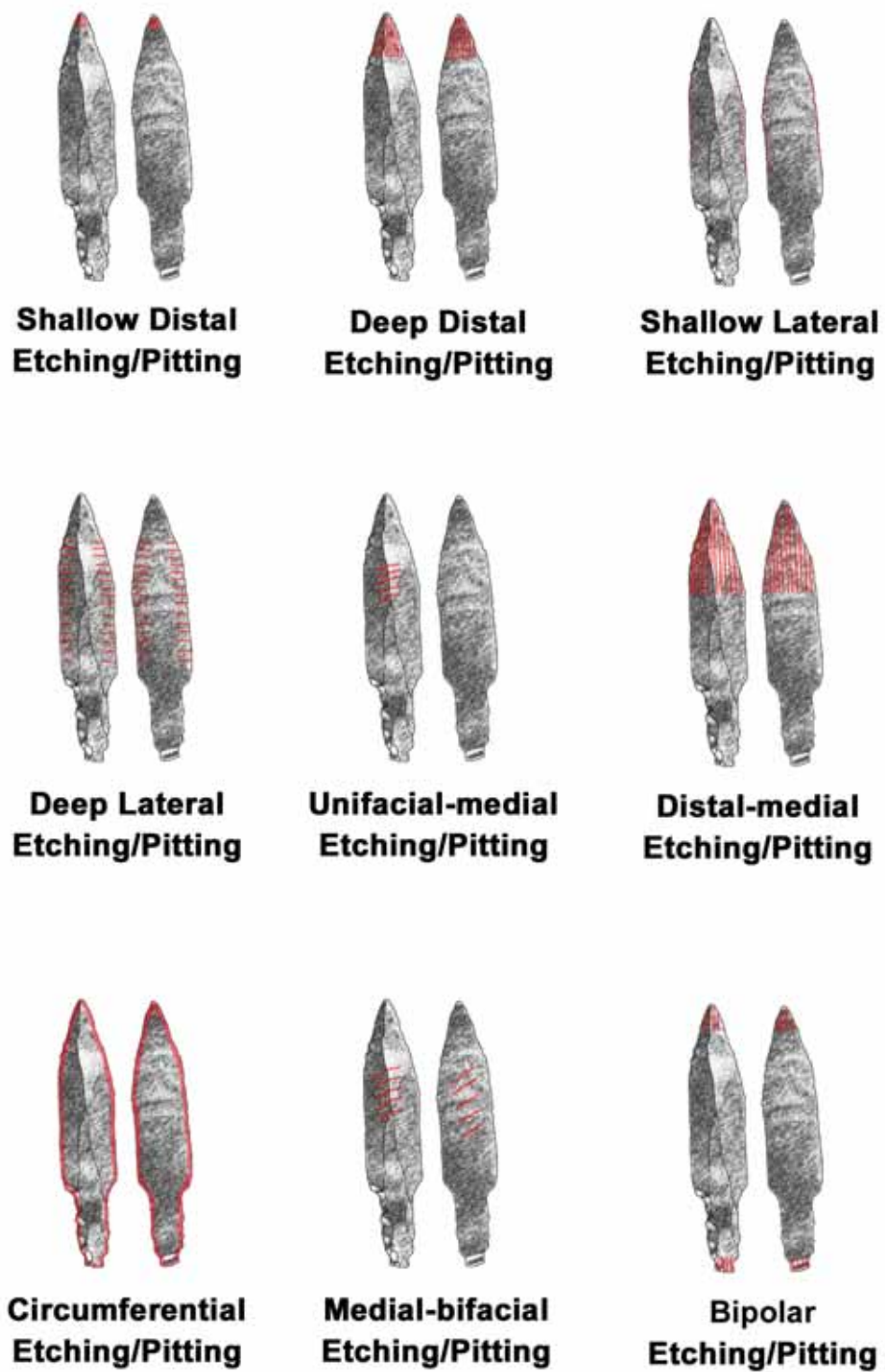


Figure 39: Patterns of etching and pitting recorded for formal stone tools at Blue Creek

Far more attention has been given to studying the use-wear present on Mesoamerican obsidian than has been expended toward the study of non-obsidian tools. There may be several practical reasons for these discrepancies that transcend the bias Mesoamerican researchers have shown toward the study of obsidian over chert. First, chert tools were likely more multifunctional. The greater durability of chert over obsidian would make it more suitable for most domestic and extra-domestic tasks. Thus, it is more difficult to produce an experimental reference set to which archaeological materials may be compared for chert than obsidian. Tool form does not readily correlate to function, and the variable wear patterns evident on many chert forms suggest that some tools were commonly used for a variety of tasks. In addition, non-obsidian tools may not develop or preserve use-wear as clearly as obsidian does. The fine-grained, smooth-surfaced nature of obsidian may provide an ideal medium for the formation of use-wear, which cannot be matched by the relatively coarse-grained, rough surfaces of the cherts, chalcedonies, quartzites, and dolomites that are commonly recovered among lowland Maya lithic assemblages.

Research Methods: Debitage

The works of many accomplished researchers have influenced the analytical approach that I used to study thedebitage at the site of Blue Creek. There is a great deal of information that may be gained from the study ofdebitage in archaeological assemblages, and researchers have debated the utility of various classes of information, as well as their situational applicability, accuracy, and level of efficiency (Ahler 1989; Andrefsky 1998; Baumler and Downum 1987; Johnson 1989; Magne 1989; Sullivan and Rossen 1985). I chose the attributes that I recorded and analyzed in this study for their ability to answer specific research questions. The approach that I ultimately adopted in this analysis is a synthesis of established methods that maximizes the amount of information gathered given time constraints and the natural limitations of studies that are performed in the field.

The variables that I recorded for debitage include both contextual data and physical attributes. Contextual data includes archaeological context (site, structure, operation, suboperation, lot, etc.) and chronology, as provided by associated ceramic types. The physical attributes that I studied include size grade, raw material source, percentage of cortex represented, platform type, presence or absence of thermal alteration, and presence of edge modification. I combined these attributes into criteria lists, and I recorded the number of flakes that fit a given set of criteria, as well as their combined weight (eg. RK2D-2; size 4; local material; cortical platform; no heat alteration; edge modified; N=14; WT=24g). This system allows for numerous unique attribute combinations for all debitage from a given context, crafted from a given raw material, and of a particular size grade. This system works efficiently for large volumes of material and produces an easily queried database.

Size-grade Analysis

I sorted all debitage by size-grade using nested sieves with 1-inch, $\frac{3}{4}$ -inch, $\frac{1}{2}$ -inch, and $\frac{1}{4}$ -inch apertures. Size-grade analysis offers an alternative to taking standard metric measurements of maximum flake length, width, thickness (cf. Andrefsky 1998: 96-100) that substantially increases the efficiency with which large samples may be studied (Ahler 1989). When combined with supplementary data, such as the percentage of dorsal cortex present and platform type, size-grade analysis provides researchers with valuable information regarding production trajectory, method and the organization of raw material procurement, technology of production, production efficiency, and the level of material curation (Ahler 1989; Baumler and Downum 1987; Behm 1983; Bradbury and Franklin 2000).

Sullivan and Rozen (1985:759) have advocated using the analytical categories “complete flake”, “broken flake”, “flake fragment”, and “debris” for the study of flake assemblages, and have illustrated the tendency for each to be represented in different proportions at various stages of manufacture (see also Baumler and Downum 1987). I did not follow this method at Blue Creek because there are far too many variables which

undermine the utility of this approach. Much of the Blue Creek settlement zone is used for pasture or is cultivated, and near-surface deposits are highly susceptible to trampling and to disturbance by agricultural machinery. Either agent will distort the ratio of complete to broken flakes in such contexts. Ancient disturbances are equally likely to affect this ratio. As the Blue Creek excavations focused heavily on civic and residential architecture, a high percentage of flakes and formal tools were recovered from structural fill. Neither the integrity of individual specimens nor the original composition of the manufacturing assemblage would have been preserved in such contexts.

Raw Material Source

I assessed raw material source using qualitative means. Consistent and visually discernable variability in raw material properties across the project area allowed for the assessment of resource procurements nodes in many instances. However, successful identification of specific material resources depends on matching artifacts (formal tools and debitage) to geological samples taken from individual resource nodes. The criteria that I used in matching archaeological materials to geological samples include lithology, material hardness, relative grain size, color, the presence or absence of banding, and the presence and composition of micro-fossils and other inclusions. In most instances, determining the area of procurement depends on artifact mass. For debitage, I could generally discern the area of procurement only for pieces large enough to be caught by the ½-inch mesh sieve because smaller fragments often lack distinguishable characteristics. To increase the accuracy of identification, I recorded only the general area of resource availability. Thus, I recorded lithic resources as “local” when available in the Blue Creek settlement zone, “regional” for the material available within the western *bajo* region, “NBCZ exotic” for material derived from northern Belize chert zone sources, and “FGB exotic” for the fine-grained brown variety of chert that must derivative from an unidentified exotic source.

FGB chert is mottled dark brown to gray, with gray patches being more opaque and characterized by a slightly coarser grain. This chert is some of the finest anywhere

in Mesoamerica. The raw material is exotic to Blue Creek, and its area of origin is presently unknown. Artifacts manufactures from this material at Blue Creek include various eccentric forms, stemmed bifaces, and laurel leaf bifaces.

Cortex Percent

Perhaps the most common use of cortex in debitage analysis is for assessing the stage of manufacture represented by the flake assemblage. Researchers commonly use one of two models of assigning meaning to the percentage of cortex present. The first uses the relative amount of cortex present on each flake to place the individual piece within a linear reduction model, under the assumption that only flakes produced during the initial phases of tool manufacture will exhibit a high percentage of dorsal cortex. Andrefsky (1998:111) refers to this as the “triple cortex” approach, and it can be recognized by the identification of “primary,” “secondary,” and “tertiary” flakes. As researchers Sullivan and Rozen (1985:756-757) have pointed out, however, there is little standardization among those employing the triple cortex approach, such that the flakes designated as “primary” may be required to have as much as 100 percent dorsal cortex or as little as 50 percent. Similarly, the percentage of dorsal cortex required to identify a secondary flake ranges between 100 and 0 percent depending on the researcher, while the percentage of dorsal cortex required for the identification of a tertiary flake ranges from between 0 and 25 percent (Sullivan and Rossen 1985:757, Figure 1).

Ahler (1989:90) has pointed out that the presence of cortex in a lithic waste assemblage -as well as the utility of information gleaned from its study- will vary according to the nature of the raw material, how it was quarried, the reduction technology employed, and the stage of manufacture represented by the assemblage. Also, the presence of cortex at any reduction stage is dependent on the initial presence of cortex prior to reduction (Andrefsky 1998:113-114). The nature of raw material formations, the method of quarrying employed, and the technology of production affect the viability of using cortex % as an indicator of production stage. However, even under

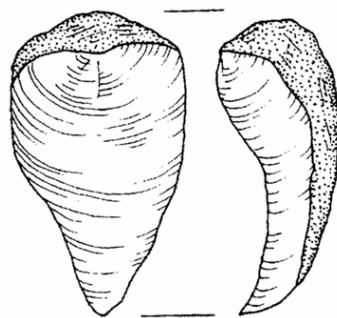
the best of circumstances, cortex percent may only provide data relevant to broadly distinguish early reduction stages from later stages (Mauldin and Amick 1989:71).

Flaked stone tools produced at Blue Creek were manufactured almost exclusively from siliceous cobbles, thus the presence and percentage of cortex in the waste assemblage provides useful information with regard to the analysis of reduction technology and manufacturing stage. Cortex categories that I recorded in this study include 0%, 1-25%, 26-75%, and 76-100%.

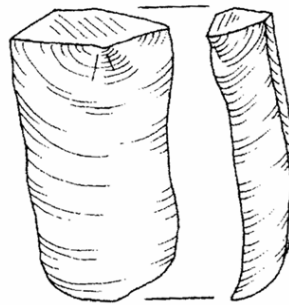
Platform Type

The striking platform of a flake is the point of contact where the percussor initiated the flake detachment. The morphology of the platform can yield valuable information pertaining to the stage of manufacture represented by the flake. Platform morphology can also inform us about production technology (Andrefsky 1998). The platform types that I recognized in this study include cortical, flat, complex, abraded, and rejuvenated (cf. Andrefsky 1998:93-96; Figure 40). Cortical platforms are those that retain some amount of unmodified cortex, and are generally derivated from early production stages. Cortical flakes also generally, but do not necessarily, exhibit dorsal cortex. Flat striking platforms exhibit a smooth, un-faceted striking surface. Flakes detached from unidirectional cores generally exhibit flat platforms (Andrefsky 1998:94), although flakes with flat striking platforms may also be produced in the early stages of bifacial core reduction. Complex striking platforms are generally multifaceted in appearance. Although researchers have had some success in determining manufacturing stage using facet counts (Mauldin and Amick 1989; McAnany 1988), time constraints precluded gathering this attribute for the debitage assemblage in this study. Flakes that exhibited bifacial retouch are generally described as bifacial thinning flakes; I also recorded these as exhibiting complex platforms. Finally, abraded platforms are those that exhibit attrition that results from purposeful edge preparation procedures. Such platforms are generally rounded or ground in appearance, and often exhibit multiple tiny step fractures. Marginal abrasion is a common practice for preparing a striking platform,

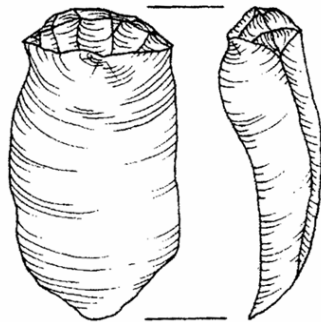
and serves as a method of altering the direction of percussor force, which produces a more predictable flake removal (Andrefsky 1998:96; Whittaker 1994). Abraded platforms are produced in all phases of tool manufacture, but are more common in later stages of production.



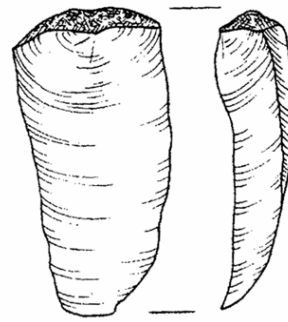
cortical platform



flat platform



complex platform



abraded platform

Figure 40: Striking platform types used in the analysis of debitage at Blue Creek (adapted after Andrefsky 1998, Fig. 5.6).

I also recorded indeterminate identifications, which generally resulted from poorly represented or wholly absent platforms, or from those that were obscured by heavy patina. I did not record platform width and thickness or the number of facets present on the dorsal surface of flakes. These attributes are not efficiently recorded through mass analysis procedures, and the information they provide may be ascertained through other means, such as by comparing the percentage of dorsal cortex present with flake size and platform type.

Material Alteration

Material alteration occurs due to natural and cultural processes. The most commonly observed and identifiable forms of alteration among debitage from Blue Creek and the western *bajo* sites were patination and heat alteration. As discussed above in the section on formal tool analysis, patinas are primarily the result of chemical weathering. Those I noted in the debitage assemblage were invariably of the white variety, and when present, they often inhibited the detection of use-wear. Patina formation also frequently precluded the assessment of material type and a determination of the zone of resource derivation.

I assessed heat alteration when possible. Accurate assessment was often inhibited by artifact size, patina formation, and my unfamiliarity with some of the lithological variability expressed by select raw materials. Lithic raw materials typically undergo significant and detectable lithological changes when exposed to extreme heat. Such changes are often desirable and may be deliberately generated by tool producers through controlled firing. Heat-treated materials may be more easily worked by the artisan, and low-quality materials may be made more useful. Thus, the identification of heat-treated materials brings culture process and the details of economic activity to the fore. Nonetheless, it is frequently difficult to distinguish purposefully treated materials from those that were incidentally burned. Incidental firing occurred in antiquity through controlled agricultural field burns, as well as the occasional burning of middens. Modern incidental firing has occurred as the result of burning off surface vegetation

when preparing land for cultivation of pasture. This practice has certainly affected the integrity of near-surface deposits throughout much of the project area.

Edge Modification

Marginal attrition of debitage may result from either natural or cultural processes. The criteria I used to identify cultural modification of flakes is essentially identical to that I used to assess flaking and polish wear on formal tools in that I only recorded flakes with margins exhibiting both flaking and worn or polished facets as utilized tools. In addition, I only identified as tools flakes on which attrition was concentrated along a defined edge (cf. Odell and Odel-Vereecken 1980). Although edge modification may result from processes other than use, natural damage and damage caused by post-depositional processes such as trampling is often randomly distributed about the flake (Odell and Odel-Vereecken 1980; Tringham, et al. 1974), and would not likely exhibit polish along its margins.

In the present study, I recorded edge modification as a way of monitoring the degree of material conservation. Regions characterized by a scarcity of utilitarian lithic raw materials have been shown to exhibit higher levels of material recycling (McAnany 1988), although such differences have been primarily identified between sites rather than within them. In the present study, I recorded edge modification as either present or absent. I did not record the pattern of edge-wear for expedient tools that lack functionally specific designs, but I recorded flake tools with functionally specific forms, such as scrapers, graters, denticulates, drills, and burins as such when I identified them.

Metric Attributes (Number and Weight)

In the interest of analytical efficiency, I did not weigh individual flakes. First I sorted by size flakes from a given context. Following this, I separated by material source. I then sorted flakes derived from materials of a given resource zone and within a particular size group, according to whether or not they were evidently heat modified, with indeterminate flakes counted as unmodified. I experimentally heated several chert

and chalcedony cobbles to produce a reference set for assessing the presence of alteration. I then sorted flakes within a modification group according to the amount of dorsal cortex present. From each of the cortex sets, I then grouped flakes by platform type. Finally, I separated flakes within each platform set by whether or not the edges were modified. I then counted the total number of flakes in each of these final groupings and collectively weighed them in grams.

The relative percentage of flakes and the relative weight of materials derived from specific resource zones are both potentially important measures of consumer choice and the ease of resource access. Debitage analysis offers a particularly insightful measure of raw material access because material waste is much less likely to travel away from its zone of production than are finished tools. The relative level of material conservation may also be compared spatially and temporally throughout the Blue Creek settlement zone by observing the degree of informal tool use and the level of tool recycling.

Ultimately, data derived from formal tool anddebitage analyses are complementary. Each data set provides a more informed perspective on the other. Individually, however, each set of data may make a distinct contribution with respect to illuminating a particular set of cultural processes and behaviors. The next chapter tests the hypotheses set forth at the beginning of this work through a detailed analysis of formal tools, *ad hoc* tools, and waste flakes recovered in the excavations at Blue Creek, the lithic workshop and the courtyard at Bedrock, and the courtyard at Sotohob.

CHAPTER VI

TESTING THE ROLE OF LITHIC RESOURCE CONTROL AS A DETERMINANT OF SOCIAL STATUS AT BLUE CREEK, BELIZE.

Introduction

In this section I use data derived from the analysis of formal stone tools, informal stone tools and waste flakes recovered in excavations at various locations throughout the Blue Creek settlement zone. I first illustrate spatial and temporal patterns observed in lithic raw material procurement, stone tool production, lithic resource distribution and consumption, and material conservation. In all instances, I refer to raw materials available within the Blue Creek settlement zone as “local”, raw materials available in the *bajo* region 12-15km west of the Blue Creek settlement zone as “regional”, raw materials that outcrop in the northern Belize chert-bearing zone as “NBCZ”, and the as yet un-sourced exotic fine-grained brown cherts that enter the material record at Blue Creek during the Late Classic period as “FGB”.

Spatial and temporal trends in the distribution and consumption of the various lithic resources show the value of using lithic artifacts as a sensitive indicator of organizational change in the Maya lowlands. Following this exploration of the Blue Creek data set, I test the research hypotheses laid out at the beginning of this work. The chapter concludes with an overview of findings where I address the central questions of critical economic resources and the alienation of these resources by some members of the community as a means of developing and maintaining inequalities in power, prestige, and wealth.

Spatial and Temporal Patterns Observed in Lithic Resource Analysis at Blue Creek *Raw Material Identification*

My identification of material source area for debitage was greatly influenced by artifact size. Figure 41 shows that the percentage of unidentified material increased significantly as flake size decreased. An identification of material source area was also complicated by patina formation and fire alteration. The difficulty with visually

sourcing small-size debitage is likely to decrease the resolution of late-stage production activities, and is likely to have a minor effect on efforts to assess whether or not regional materials entered Blue Creek in raw form or as finished products. I will address this issue later in this chapter. Studies have also achieved substantial success in distinguishing distinct phases of lithic reduction based on flake size distributions (Ahler 1988, 1989; Raab et al. 1978). However, the percentage of flakes recorded from various size classes are skewed for all areas of the site, with the proportion of the assemblage comprised of flakes from 1-inch, $\frac{3}{4}$ -inch, and $\frac{1}{2}$ -inch sieves inflated, while the flakes from $\frac{1}{4}$ -inch sieves are under-represented. This distortion in the data is a regrettable but necessary occurrence. I assigned the highest priority to accuracy in raw material identification during the process of analyzing the Blue Creek lithic assemblage. However, I made certain compromises to ensure the validity of the data gathered.

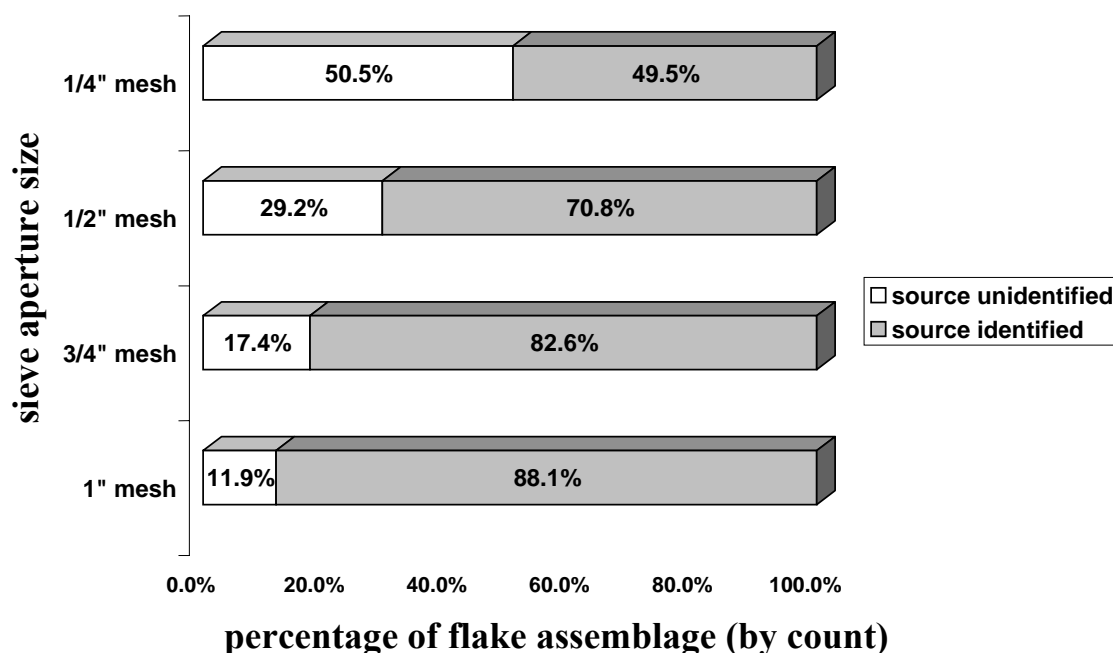


Figure 41: Raw material source identification among the Blue Creek flake assemblage by flake size.

When comparing the distribution of raw materials throughout the Blue Creek settlement zone, I gave analytical weight to the proportion of the various raw materials in a given context rather than to the absolute number of artifacts crafted from a given raw material. I did this to mitigate the effects of excavation bias. For example, 57.4% of the debitage (by count; 66.4% by weight) recovered from Early Classic contexts came from deposits in the site core. As no other Early Classic contexts received the archaeological attention given to the site core (in terms of the number of areas excavated or the total volume of excavated area), a strict volumetric assessment of raw material representation would unjustifiably conclude that access to and consumption of all raw materials was dominated by elites residing in the site core based on a biased dataset. The context-specific percentages I used offer a more sophisticated (if less direct) means to address issues of material access, distribution, and consumption.

Lithic Raw Material Procurement, Distribution and Consumption

Middle Preclassic Period Patterns

Lithic materials dating to the Middle Preclassic period (1000/800-350 BC) have been recovered from both the savannah settlement zone and upper-escarpment contexts, but are not numerous from either location. A total of 30 formal tools and 447 pieces of debitage (12 exhibiting use wear) were recovered from Middle Preclassic contexts (Tables 3-5).

Table 3: Middle Preclassic raw material representation among flakes within the Blue Creek settlement zone weighted by count.

raw material source	unidentified	local	regional	NBCZ	total
Savannah non-elite	3	15	17	2	37
	8.1%	40.5%	45.9%	5.4%	8.3%
Site core	125	164	121	0	410
	30.5%	40.0%	29.5%	0.0%	91.7%
total	128	179	138	2	447
	28.6%	40.0%	30.9%	0.4%	100%

Table 4: Middle Preclassic raw material representation among flakes within the Blue Creek settlement zone weighted by material weight (grams).

raw material source	unidentified	local	regional	NBCZ	total
Savannah non-elite	13	214	267	8	502
	2.6%	42.6%	53.2%	1.6%	30.0%
Site core	271	457	442	0	1170
	23.2%	39.1%	37.8%	0.0%	70.0%
total	284	671	709	8	1672
	17.0%	40.1%	42.4%	0.5%	100.0%

Table 5: Middle Preclassic raw material representation among formal tools within the Blue Creek settlement zone.

raw material source	unidentified	local	regional	NBCZ	total
Savannah non-elite	1	0	3	2	6
	16.6%	0.0%	50.0%	33.3%	20.0%
Western Group	1	0	2	0	3
	33.3%	0.0%	66.7%	0.0%	10.0%
Site core	6	1	10	4	21
	28.6%	4.8%	50.0%	20.0%	70.0%
total	8	1	15	6	30
	26.7%	3.3%	50.0%	20.0%	100%

The most striking aspect of the Middle Preclassic assemblage is the presence of chert from northern Belize outcrops. This chert comprises only 0.4% of debitage by count (Table 3), but constitutes 20.0% (N=6) of all formal tools recovered from this period (Table 5). If the Middle Preclassic contexts at Blue Creek are indeed pure, uncompromised contexts, as current evidence suggests that they are, then the distribution of production items from northern Belize workshops to distant consumer sites may have occurred several hundred years earlier than is currently believed (Shafer and Hester 1983). Minimally, the data illustrate an early reliance on external raw material sources at Blue Creek. This is further supported by the flake data, which suggest that the Middle Preclassic community at Blue Creek had an almost equal reliance on locally and regionally available materials.

Weight and count flake data from Tables 3 and 4 show that there is a statistically significant difference in the distribution of various raw materials between settlement contexts whether flakes of unidentified material are considered or not (count, including unidentified: $\chi^2 = 31.07$, $df = 3$, $p = .000$; excluding unidentified: $\chi^2 = 18.14$, $df = 2$, $p = .000$; weight, including unidentified: $\chi^2 = 126.96$, $df = 3$, $p = .000$; excluding unidentified: $\chi^2 = 19.82$, $df = 2$, $p = .000$). However, there is no statistically significant difference in the distribution of lithic material resources from which formal tools were manufactured (Table 5) (including unidentified: $\chi^2 = 2.07$, $df = 6$, $p = .914$; excluding unidentified: $\chi^2 = 1.66$, $df = 4$, $p = .798$).

Based on data provided in the tables above, there is some evidence to suggest that settlements above and below the escarpment enjoyed differential access to materials from the identified resource areas during the Middle Preclassic period. However, deposits from this period are notoriously difficult to find archaeologically (Aimers, et al. 2000), and any differences observed between different settlement contexts is as likely to be a product of recovery as it is to be the product of cultural behavior. There is no evidence that Blue Creek was socio-economically differentiated during the Middle Preclassic. Thus, Guderjan (1996) postulated that the site was little more than a nucleated village at this time.

Late Preclassic Period Patterns

A significant amount of lithic material dating to the Late Preclassic (350 BC – AD 100/150) and Terminal Preclassic (AD 100/150-250) periods has been recovered from both the savannah settlement zone and contexts above the escarpment. I consider these periods together to preserve a statistically valid sample size. A total of 185 formal tools and 616 pieces of debitage (13 exhibiting use wear) were recovered from these combined Late Preclassic contexts. While some socio-economic differentiation is evident within the savannah community at this time, Table 6 shows that only 0.6% (N=4) of the flakes studied come from a savannah elite context. Due to this small sample size, I do not assume that the data accurately represent the actual distribution of

lithic resources throughout this zone. Thus, the contrast emphasized during the Late Preclassic period is between non-elite settlements across the savannah landscape below the escarpment and the now decidedly elite contexts above the escarpment.

Table 6: Late Preclassic raw material representation among flakes within the Blue Creek settlement zone weighted by count.

raw material source	unidentified	local	regional	NBCZ	total
Savannah non-elite	55	27	125	53	260
	21.2%	10.4%	48.1%	20.4%	42.2%
Savannah elite	0	1	3	0	4
	0.0%	25.0%	75.0%	0.0%	0.6%
Site core	133	93	124	2	352
	37.8%	26.4%	35.2%	0.6%	57.1%
total	188	121	252	55	616
	30.5%	19.6%	40.9%	8.9%	100%

Table 7: Late Preclassic raw material representation among flakes within the Blue Creek settlement zone weighted by material weight (grams).

raw material source	unidentified	local	regional	NBCZ	total
Savannah non-elite	334	178	471	177	1160g
	28.8%	15.3%	40.6%	15.3%	43.8%
Savannah elite	0	4	19	0	23g
	0.0%	17.4%	82.6%	0.0%	0.9%
Site core	373	653	420	22	1468g
	25.4%	44.5%	28.6%	1.5%	55.4%
total	707	835	910	199	2651g
	26.7%	31.5%	34.3%	7.5%	100.0%

Table 8: Late Preclassic raw material representation among formal tools within the Blue Creek settlement zone.

raw material source	unidentified	local	regional	NBCZ	Total
Escarpment non-elite	3	0	0	0	3
	100.0%	0.0%	0.0%	0.0%	1.6%
Savannah non-elite	34	10	31	31	106
	32.1%	9.4%	29.2%	29.2%	57.3%
Western Group	0	0	1	1	2
	0.0%	0.0%	50.0%	50.0%	1.1%
Site core	16	8	25	25	7474
	21.6%	10.8%	33.8%	33.8%	40.0%
total	53	18	57	57	185
	28.6%	9.7%	30.8%	30.8%	100.0%

Weight and count flake data from Tables 6 and 7 show that there is a statistically significant difference in the distribution of various raw materials between settlement contexts whether flakes of unidentified material are considered or not (count, including unidentified: $\chi^2 = 107.73$, $df = 6$, $p = .000$; excluding unidentified: $\chi^2 = 84.45$, $df = 4$, $p = .000$; weight, including unidentified: $\chi^2 = 393.18$, $df = 6$, $p = .000$; excluding unidentified: $\chi^2 = 379.79$, $df = 4$, $p = .000$). However, there is no statistically significant difference in the distribution of lithic material resources from which formal tools were manufactured (Table 8) (including unidentified: $\chi^2 = 11.12$, $df = 9$, $p = .268$; excluding unidentified: $\chi^2 = 0.32$, $df = 4$, $p = .988$).

The trend of relying on external resource areas to fill local lithic needs continued and was accentuated in the Late Preclassic when compared to the Middle Preclassic period. Extrapolating from data provided in Table 8, of all formal tools from an identified material source 43.2% come from a regional source, 43.2% come from a NBCZ source, and only 13.6% are crafted from locally available materials. This suggests that Blue Creek lacked the ability to be self-sufficient with regard to procuring critical economic resources.

While NBCZ resources are very prevalent in the Late Preclassic formal tool assemblage at Blue Creek (Table 8), they constitute only a small amount of the debitage (8.9% by count, 7.5% by weight) (Tables 6 and 7). This strongly suggests that NBCZ

materials were entering Blue Creek as finished tool forms. Conversely, the high percentage of material waste from local and regional resources suggests that tool production using these raw materials was also occurring in the Blue Creek settlement. However, as waste from local and regional sources are both relatively abundant, the significantly greater number of tool forms from regional sources suggests that both finished products and raw materials were entering the Blue Creek community. I address the subject of lithic production and resource importation in greater detail below.

It is interesting that virtually no NBCZ debitage occurs in elite contexts above the escarpment from the Late Preclassic period, while it is fairly common in non-elite savannah contexts. I interpret this as a functional contrast. Tool forms from NBCZ sources are typically found in a used and often recycled state in domestic deposits in non-elite contexts below the escarpment. In elite contexts above the escarpment, NBCZ resources are more frequently included in ritual cache deposits, and do not typically display the signs of material recycling that are rather frequently observed in non-elite contexts.

Another interesting pattern that develops during the Late Preclassic period concerns the representation of local material resources between elite and non-elite contexts. The relative representation of local production waste is much higher in elite contexts above the escarpment (26.4% vs. 10.4% by count [Table 6], 44.5% vs. 15.3% by weight [Table 7]). Escarpment elite contexts exhibit generally larger production waste, as well as a larger overall volume of production waste from local material resources. While neither escarpment elite nor savannah non-elite contexts are seemingly more likely to employ tools crafted from local resources (see Table 8), the preponderance of local material production waste in elite contexts above the escarpment is evidence that elites were controlling access to and production of local lithic raw material resources by the Late Preclassic period.

Early Classic Period Patterns

Lithic materials dating to the Early Classic period (AD 250-600) were recovered primarily from elite contexts above the escarpment and socio-economically differentiated contexts below the escarpment. A total of 225 formal tools and 1495 pieces of debitage (42 exhibiting use wear) were recovered from Early Classic contexts (Tables 9 – 11). Important contrasts exist between zones in the amount of local materials represented.

Table 9: Early Classic raw material representation among flakes within the Blue Creek settlement zone weighted by count.

raw material source	unidentified	local	regional	NBCZ	total
Escarpment non-elite	0	1	0	0	1
	0.0%	100.0%	0.0%	0.0%	0.1%
Savannah non-elite	46	31	36	20	133
	34.6%	23.3%	27.1%	15.0%	8.9%
Savannah elite	94	64	94	42	294
	32.0%	21.8%	32.0%	14.3%	19.7%
Rio Hondo	133	33	19	21	206
	64.6%	16.0%	9.2%	10.2%	13.8%
Western Group	1	1	1	0	3
	33.3%	33.3%	33.3%	0.0%	0.2%
Site core	60	769	29	0	858
	7.0%	89.6%	3.4%	0.0%	57.4%
total	334	899	179	83	1495
	22.3%	60.1%	12.0%	.6%	100%

Table 10: Early Classic raw material representation among flakes within the Blue Creek settlement zone weighted by material weight (grams).

raw material source	unidentified	local	regional	NBCZ	total
Escarpment non-elite	0	12	0	0	12g
	0.0%	100.0%	0.0%	0.0%	0.1%
Savannah non-elite	72	134	168	59	433g
	16.6%	30.9%	38.8%	13.6%	2.7%
Savannah elite	756	1072	1932	314	4074g
	18.6%	26.3%	47.4%	7.7%	25.2%
Rio Hondo	338	302	148	91	879g
	38.5%	34.4%	16.8%	10.4%	5.4%
Western Group	2	20	2	0	24g
	8.3%	83.3%	8.3%	0.0%	0.1%
Site core	594	9869	274	0	10,737g
	5.5%	91.9%	2.6%	0.0%	66.4%
total	1762	11,409	2524	464	16,159g
	10.9%	70.6%	15.6%	2.9%	100.0%

Table 11: Early Classic raw material representation among formal tools within the Blue Creek settlement zone.

raw material source	unidentified	local	regional	NBCZ	total
Escarpment non-elite	3	2	0	0	5
	60.0%	40.0%	0.0%	0.0%	2.2%
Savannah non-elite	5	1	8	5	19
	26.3%	5.3%	42.1%	26.3%	8.4%
Savannah elite	9	5	25	32	71
	12.7%	7.0%	35.2%	45.1%	31.6%
Rio Hondo	6	5	4	6	21
	28.6%	23.8%	19.0%	28.6%	9.3%
Western Group	6	0	2	4	12
	50.0%	0.0%	16.7%	33.3%	5.3%
Site core	25	16	35	21	97
	25.8%	16.5%	36.1%	21.6%	43.1%
total	54	29	74	68	225
	24.0%	12.9%	32.9%	30.2%	100%

Weight and count flake data from Tables 9 and 10 show that there is a statistically significant difference in the distribution of various raw materials between settlement contexts whether flakes of unidentified material are considered or not (count, including unidentified: $\chi^2 = 866.53$, $df = 15$, $p = .000$; excluding unidentified: $\chi^2 =$

555.45, $df = 10$, $p = .000$; weight, including unidentified: $\chi^2 = 8165.08$, $df = 15$, $p = .000$; excluding unidentified: $\chi^2 = 7304.04$, $df = 10$, $p = .000$). There is also a statistically significant difference in the distribution of lithic material resources from which formal tools were manufactured (Table 11) (including unidentified: $\chi^2 = 34.22$, $df = 15$, $p = .003$; excluding unidentified: $\chi^2 = 25.73$, $df = 10$, $p = .004$).

There is an obvious disparity in the amount of local resources represented among the various settlement contexts. It appears relevant that elite contexts above the escarpment in the site core came to dominate the utilization of local resources during the Early Classic period. Of all flakes recovered from Early Classic contexts throughout the site, 85.5% (by count; 86.5% by weight) of all local materials were recovered from the site core. Of all the debitage obtained from Early Classic deposits in the site core, 91.1% is local material. These figures are clear in their depiction of upper-escarpment elite dominance of locally available utilitarian lithic resources.

However, while local resources account for 70.6% (by weight; 60.1% by count) of all Early Classic debitage, only 12.9% of all Early Classic formal tools have been identified as having been crafted from local materials. Tools crafted from regional materials account for 32.9% of the Early Classic assemblage, while 30.2% of the assemblage was crafted from NBCZ materials. The disparity observed here in the representation of local lithic resources within the Early Classic debitage and formal tool assemblages can be accounted for by considering the loci of tool manufacture. The low representation of regional and NBCZ material among the debitage assemblage indicates that these resources entered the Blue Creek community as finished products (although it is possible that a small amount of regional material may have entered the community in raw form). Local materials were processed within the Blue Creek community, most likely within the elite settlement zone above the escarpment.

Again, it is interesting that no NBCZ debitage is found in elite contexts above the escarpment. Tools crafted from NBCZ chert comprise 21.6% of all tool forms recovered in site core excavations, yet absolutely no NBCZ flakes were recovered during those excavations. By comparison, tools crafted from NBCZ cherts comprise 45.1% of tool

forms and 14.3% debitage (by count; 7.7% by weight) recovered from elite contexts in the savannah settlement zone. This difference may also be explained functionally based on qualitative observations. Tool forms invariably appear to have been principally used in utilitarian tasks below the escarpment, and are more frequently included within ritual contexts in elite contexts above the escarpment.

Blue Creek's continued reliance on imported economic resources is evident from the percentage of tools crafted from regional and NBCZ materials, which together account for 63.1% (83.1% excluding those from an unidentified source) of all tools. Local raw materials within the Blue Creek settlement zone are of comparatively poor quality, and are not likely to have offered as long a use life as the finer quality tools exported from regional and NBCZ production localities. Utilitarian raw materials are also scarce in the Blue Creek settlement zone, and may not have been able to meet consumer demand. It is also possible that lithic resources from external source areas presented Blue Creek's disenfranchised hinterlands with an alternative to relying on local elites for provisioning important economic resources, thus decreasing their indebtedness to local potentates. This point will be revisited in the following chapter.

Late Classic Period Patterns

Lithic materials dating to the Late Classic period (AD 600-1000) were recovered from all settlement contexts. The greatest difficulty with regard to studying Late Classic period deposits is the fact that they exist at or near the ground surface and are much more likely to have been disturbed through modern processes than are older, more deeply buried deposits. Ephemeral non-elite features are particularly susceptible to disturbance. Thus, the Late Classic period lithic assemblage better reflects patterns of resource use at the middle and upper tiers of the socio-economic hierarchy.

The beginnings of the Late Classic period followed the massive sixth-century termination event occurring at Structure 4 in the site core (Guderjan 1998, 2001, 2002). Elite residences in the site core flourished following this event, though the precinct itself remained the administrative and ceremonial nexus of the community. However, the

Western Group appears to have ascended to the center of elite courtly life at Blue Creek during the Late Classic period. It is possible that this transformation of the elite community was also associated with a fundamental alteration in resource use rights throughout the Blue Creek community as a whole, although there is some evidence to suggest that elites in the Late Classic period continued to dominate lithic resource production.

One of the most significant changes from the Early Classic period to the Late Classic period is the relative amount of local and regional material waste found in deposits throughout the settlement zone (Tables 12 – 14). For example, in elite contexts above the escarpment, 91.9% of all flakes recovered (by weight, Table 10) in Early Classic site core deposits were identified as local material, while only 2.6% were identified as regional. In contrast, only 39.4% of all flakes (by weight) recovered in Late Classic site core deposits were identified as locally available material, while 35.5% were identified as regional. The Western Group, representing a second Late Classic elite context above the escarpment, had only 43.9% local material compared to 34.1% regional material (calculated by weight). This represents a major shift from the Early Classic period where local raw materials dominated the lithic material assemblage in elite contexts above the escarpment. Using flake data from the site core, the difference in material usage between the Early and Late Classic periods is statistically significant at the 99% confidence interval (based on count: $\chi^2 = 430.80$, $df = 2$, $p = .000$; based on weight: $\chi^2 = 4544.80$, $df = 2$, $p = .000$). This may indicate that a greater range of activities took place in elite contexts above the escarpment during the Late Classic period because the ratio of local materials to non-local materials (measured by debitage weight and count, Tables 12 and 13) roughly mirrors that observed in the decidedly utilitarian deposits of the savannah landscape below the escarpment. Elite contexts above the escarpment certainly look less like production oriented deposits at this time, and are much more similar in appearance to deposits without an overt production orientation. It may also indicate that stone tool production became less associated with elite residences during the Late Classic period, though this inference is not largely

supported by other proxy measures of production (discussed in detail below). Still, non-elite residences proliferate above the escarpment during this period, and stone tool production may have fallen more to attached specialists who resided at some distance from elite precincts. I cover the subject of stone tool production in greater detail below.

Table 12: Late Classic raw material representation among flakes within the Blue Creek settlement zone weighted by count.

raw material source	unidentified	local	regional	NBCZ	FGB	total
Escarpment non-elite	0	7	1	0	0	8
	0.0%	87.5%	12.5%	0.0%	0.0%	0.4%
Savannah non-elite	19	25	33	20	0	97
	19.6%	25.8%	34.0%	20.6%	0.0%	4.6%
Savannah elite	305	204	137	21	1	668
	45.7%	30.5%	20.5%	3.1%	0.1%	31.6%
Rio Hondo	196	79	24	12	0	311
	63.0%	25.4%	7.7%	3.9%	0.0%	14.7%
Western Group	185	209	176	9	0	579
	32.0%	36.1%	30.4%	1.6%	0.0%	27.4%
Site core	137	134	167	15	0	453
	30.2%	29.6%	36.9%	3.3%	0.0%	21.4%
total	642	656	536	77	1	2116
	39.8%	31.1%	25.4%	3.6%	0.0%	100%

Table 13: Late Classic raw material representation among flakes within the Blue Creek settlement zone weighted by material weight (grams).

raw material source	unidentified	local	regional	NBCZ	FGB	total
Escarpment non-elite	0	146	4	0	0	150g
	0.0%	97.3%	2.7%	0.0%	0.0%	0.8%
Savannah non-elite	46	95	87	54	0	282g
	16.3%	33.7%	30.9%	19.1%	0.0%	1.5%
Savannah elite	1553	1721	1979	273	4	5530g
	28.1%	31.1%	35.8%	4.9%	0.1%	30.1%
Rio Hondo	941	910	236	110	0	2197g
	42.8%	41.4%	10.7%	5.0%	0.0%	11.9%
Western Group	1355	2892	2243	92	0	6582g
	20.6%	43.9%	34.1%	1.4%	0.0%	35.8%
Site core	725	1439	1297	192	0	3653g
	19.8%	39.4%	35.5%	5.3%	0.0%	19.9%
total	4620	7203	5846	721	4	18,394g
	25.1%	39.2%	31.8%	3.9%	0.0%	100.0%

Table 14: Late Classic raw material representation among formal tools within the Blue Creek settlement zone.

raw material source	unidentified	local	regional	NBCZ	FGB	total
Escarpment non-elite	9	3	2	0	1	15
	60.0%	20.0%	13.3%	0.0%	6.7%	1.9%
Savannah non-elite	7	3	13	12	1	36
	19.4%	8.3%	36.1%	33.3%	2.8%	4.6%
Savannah elite	40	16	40	17	8	121
	33.1%	13.2%	33.1%	14.0%	6.6%	15.4%
Rio Hondo	21	23	6	10	0	60
	35.0%	38.3%	10.0%	16.7%	0.0%	7.6%
Western Group	101	39	160	26	39	365
	27.7%	10.7%	43.7%	7.1%	10.7%	46.4%
Site core	37	31	71	41	9	185
	19.6%	16.4%	37.6%	21.7%	4.8%	24.0%
total	215	115	292	106	58	786
	27.4%	14.6%	37.2%	13.5%	7.4%	100%

Another interesting pattern observed in the Late Classic period data relates to raw material representation among formal tools recovered within the site core and Western Group (Table 14). As these areas each represent geographically adjacent, elite space above the escarpment, they might be expected to display similar resource consumption patterns. However, this is not the case. Tools imported from NBCZ sources constitute 21.7% of all formal tools recovered from Late Classic site core deposits, while they comprise only 7.1% of the formal tool assemblage recovered from coeval Western Group deposits (Table 14). There is also a significant disparity in the distribution of FGB resources among settlement areas. An overwhelming 67.2% of all tools imported from the FGB resource zone were recovered in Western Group deposits. This sharply contrasts with the 15.5% recovered from site core deposits and the 13.8% recovered from elite savannah (Structure U-5 complex) deposits. However, this disparity can be largely attributed to a single dedicatory cache that was discovered in the Structure 37 plazuela (Hanratty 2002). This lithic cache contained 20 obsidian blades, 22 stemmed bifaces, one exceptionally large laurel-leaf biface, and one intricately crafted tripronged

eccentric. With the exception of the obsidian blades, all artifacts in the cache were crafted from FGB chert.

The relative consumption of NBCZ resources also dramatically declined in the Late Classic period in elite savannah contexts, and correspondingly, local resource use increased. Extrapolating from Table 14, if only tools from identified resource zones are considered, consumption of NBCZ resources in savannah elite contexts fell from 51.6% during the Early Classic period to 21.0% during the Late Classic period. In comparison, the consumption of local resources increased from 8.1% during the Early Classic period to 19.8% during the Late Classic period in elite savannah contexts. This mirrors the trend towards decreasing reliance on NBCZ resources and increasing reliance on local resources that was observed throughout the Blue Creek community as a whole.

Weight and count flake data from Tables 12 and 13 show that there is a statistically significant difference in the distribution of various raw materials between settlement contexts whether flakes of unidentified material are considered or not (count, including unidentified: $\chi^2 = 261.63$, $df = 20$, $p = .000$; excluding unidentified: $\chi^2 = 112.28$, $df = 15$, $p = .000$; weight, including unidentified: $\chi^2 = 1426.296$, $df = 20$, $p = .000$; excluding unidentified: $\chi^2 = 853.40$, $df = 15$, $p = .000$). There is also a statistically significant difference in the distribution of lithic material resources from which formal tools were manufactured (Table 14) (including unidentified: $\chi^2 = 107.64$, $df = 20$, $p = .000$; excluding unidentified: $\chi^2 = 93.51$, $df = 15$, $p = .000$).

As shown in Figure 42, the number of tool forms derived from NBCZ resources sharply declined in the Late Classic period. Sullivan (2002) has shown a marked regionalization in ceramics during the Late Classic period in northern Belize. The lithic data from Blue Creek suggests that such regionalization may have resulted from increasing entropy in long distance exchange systems. It is interesting that exotic chert from the FGB source area only enters the material record at Blue Creek during the Late Classic period (Figure 42). FGB chert is found at Blue Creek almost exclusively in elite contexts (96.5%), and tool forms manufactured from this material are limited to laurel leaf bifaces, stemmed bifaces, and eccentrics. In short, FGB tools are not a replacement

of NBCZ tools, because they do not fulfill the same utilitarian functions. The presence of FGB resources in Late Classic period elite deposits is likely an indication of shifting or new polity alliances that culminated at the close of the sixth century. These exotic goods are likely to have had significant prestige value, but the resource zone itself does not appear to have been economically important to Blue Creek in the same fashion that northern Belize production sites appear to have been in earlier periods.

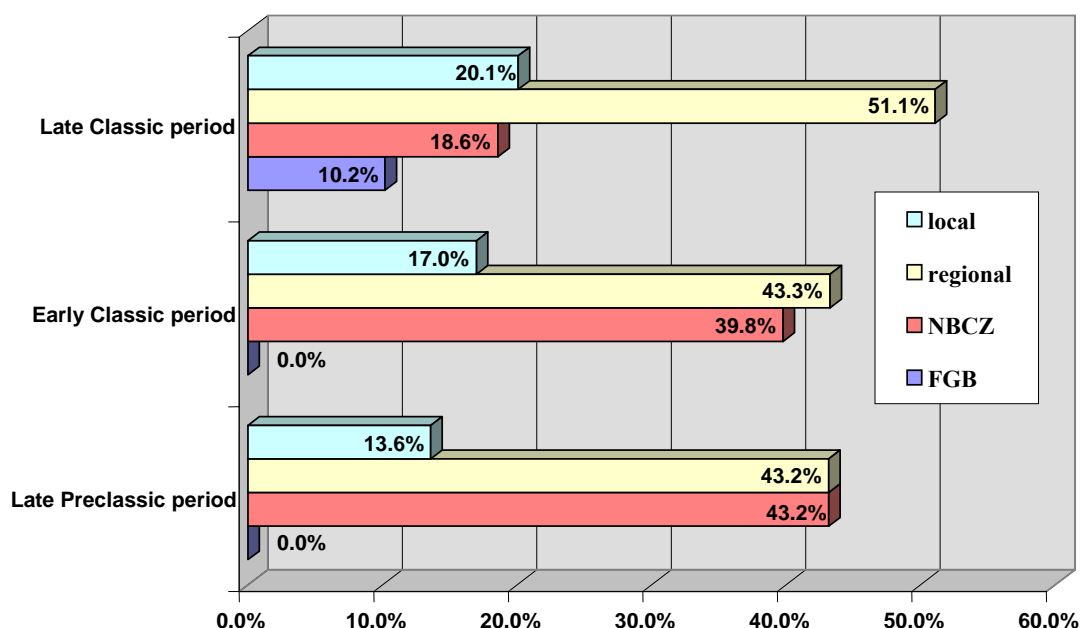


Figure 42: Representation of identified raw materials among formal tools recovered in excavations at Blue Creek. Tabulated percentages exclude tool forms from unidentified source locations.

The percentage of formal tools manufactured out of local materials increased through time, but never represented the majority of the tool assemblage for any time period. Blue Creek relied on imported stone tools throughout the length of its occupation. Alliances with other northwestern Belize centers -specifically those

affiliated with the prolific chalcedony resources of the *bajo* region to the west- were vital to the Blue Creek economy as early as the Middle Preclassic period and remained strong until the site was eventually abandoned. Regional sources experienced a moderate increase in exploitation at Blue Creek at the same time as the importance of NBCZ sources declined during the Late Classic period.

Stone Tool Production

Several centers of stone tool production have been located in the Three Rivers Region (Scarborough, et al. 2003) of northwestern Belize and eastern Guatemala. Workshops have been discovered at Chan Chich (Meadows 2000), El Pedernal (Black 1987; Black and Suhler 1986; Lewis 1995), and Bedrock (Barrett 2001). While no lithic workshops have been found within the Blue Creek settlement zone, there are several lines of indirect evidence that provide proxy measures for stone tool production. The distribution of local raw material production waste provides the first of these proxy measures. A higher volume of local material waste may be expected in areas where production occurred. The distribution of flakes with greater than 75% cortex provides a second and related measure. Local raw materials outcrop as cobbles, and the cortex is generally removed from these cobbles during the early stages of tool production. Therefore, the distribution of flakes with significant amounts of cortex on their dorsal surfaces should delineate areas of tool manufacture. In addition to production waste, lithic production loci commonly yield production failures (Michaels 1987; Shafer 1985). Tools may fail during manufacture for a number of reasons, and the identification of these failures in archaeological deposits may provide a third proxy measure of production. The final proxy measure of tool production I employ here is the distribution of hammerstones. Production waste generated in, or in proximity to, domestic space may be removed from the loci of manufacture. This displacement is likely to decrease its resolution in the archaeological record, particularly as excavation programs tend to focus on structures (J. E. Clark 1991a). Hammerstones, as the tools of manufacture, are

not likely to be removed from production areas. Thus their distribution serves to identify areas of production.

Local Resource Distribution

The distribution of raw material waste has already been partially reviewed in the above discussions of resource patterns across the Blue Creek settlement zone over time. However, this measure of production is overly reliant on the absolute volume of material waste present in various settlement contexts. As mentioned earlier, the volume of deposits excavated varied substantially across the settlement zone, thus biasing direct contextual comparisons in favor of areas that were more intensively investigated. An alternative measure is a comparison of the relative percentage of local raw materials within deposits from different zones. Areas of local production should exhibit a higher relative percentage of local material waste, whereas areas where production did not take place should exhibit a raw material representation that roughly mirrors resource consumption patterns observed among formal tools. The logic of this assertion is that waste materials recovered from purely consumption contexts will reflect commodity rejuvenation efforts, and all tool forms ideally share the same likelihood of recycling. However, there is one complicating factor in applying such a measure to the Blue Creek lithic assemblage. Resharpening flakes removed during tool rejuvenation are largely comprised of small-sized debitage, which is under-represented in this data set due to problems of raw material identification (see Figure 41). Small-size debitage forms the bulk of material waste recovered (37.2% was recorded as size -grade 4- for all time periods). As there is no way to calibrate the effects of this under-representation on the relative amount of material from each resource zone identified within each settlement precinct, this measure of production is not recommended. Each of the following measures of production activity represents a much more reliable test.

Dorsal Cortex Representation

Several authors have noted the utility of measuring the amount of cortex represented in a flake assemblage for distinguishing between various production systems (Ingbar, et al. 1989; Mauldin and Amick 1989; Tomka 1989). Mauldin and Amick (1989:70) have challenged the simplistic assumption that stages of production can be accurately tracked by the amount of cortex observed on flakes in an assemblage, finding that the presence of cortex on flakes is only an accurate measure of the early phases of production. Although flakes devoid of cortex may be produced during any phase of production, flakes exhibiting cortex on their dorsal surfaces are patently associated with the early phases of reduction. The authors produced standard sized biface blanks from three chert cobbles in an experimental reduction study (Mauldin and Amick 1989:67). One aspect of their analysis included an assessment of cortex representation on flakes produced during various phases of production. They observed some variation as the result of initial raw material package size, but some general trends were evident. Table 15 uses their data to show a comparison of dorsal cortex cover on flakes produced through experimental bifacial core reduction.

Table 15: Cortex representation on flakes produced through experimental biface reduction (after Mauldin and Amick 1989:73).

cortex %	flakes w/ 0% cortex	flakes w/ 1-50% cortex	flakes w/ 51-100% cortex	total
flake count	848	278	115	1241
percent of total	68.3%	22.4%	9.3%	100.0%

Final percentages given in Table 15 are averages, and individual cortex percentages varied for each of the three cobbles reduced in the experiment. As Mauldin and Amick (1989:69-73) point out, such percentages may vary based on the desired final product and the initial raw material package size. Percentages may also vary if production waste is recycled. For example, large flakes removed in initial core reduction may themselves become cores from which other tools may be constructed. This practice

would alter the percentage of flakes with various amounts of dorsal cortex in the assemblage.

Any comparison of the above experimental data with the Blue Creek lithic data is hindered in part by differences in how cortex percentages were recorded. Mauldin and Amick use 0%, 1-50%, and 51-100% as analytical groupings for recording the amount of dorsal cortex present on flakes, whereas this study uses 0%, 1-25%; 26-75%, and 75-100%. The choice to group 26-50% with 51-75% was based on my observation early in the analytical process that there was typically little difference in cortex representation between these groupings. Nonetheless, data from the experimental study performed by Mauldin and Amick is useful for illustrating general trends. For example, the authors observed that 68.3% of all flakes had no cortex (1989:73). Logically, an artifact assemblage dominated by stone tool forms imported in finished form and with little or no on-site production would exhibit a far greater percentage of flakes that lack cortex. By extension, areas of the site characterized by stone tool consumption without corresponding production should also display a high percentage of flakes that lack cortex. In looking at the Blue Creek lithic assemblage, clear patterns exist with regard to both import commodities and locally manufactured goods.

Data based on flake counts show that there is no statistically significant difference in the distribution of NBCZ materials through time at Blue Creek (Table 16, $\chi^2 = 4.79$, $df = 6$, $p = .570$). However, there is a statistically significant difference in the distribution of regional materials (Table 17, $\chi^2 = 22.481$, $df = 9$, $p = .007$) and local materials (Table 18, $\chi^2 = 46.58$, $df = 9$, $p = .000$) through time.

Table 16: Percentage of NBCZ material debitage (by count) showing cortex by percent group through time at Blue Creek, Belize.

NBCZ material	0% cortex	1-25% cortex	26-75% cortex	76-100% cortex	Total
Late Preclassic	53	2	0	0	55
	96.4%	3.6%	0.0%	0.0%	25.3%
Early Classic	81	1	1	0	83
	97.6%	1.2%	1.2%	0.0%	38.2%
Late Classic	77	0	0	0	77
	100.0%	0.0%	0.0%	0.0%	35.5%

Table 17: Percentage of regional material debitage (by count) showing cortex by percent group through time at Blue Creek, Belize.

regional material	0% cortex	1-25% cortex	26-75% cortex	76-100% cortex	Total
Late Preclassic	204	38	10	0	252
	81.0%	15.1%	4.0%	0.0%	22.8%
Early Classic	141	22	12	4	170
	78.8%	12.3%	6.7%	2.2%	16.2%
Late Classic	451	48	33	6	538
	83.8%	8.9%	6.1%	1.1%	48.6%

Table 18: Percentage of local material debitage (by count) showing cortex by percent group through time at Blue Creek, Belize.

local material	0% cortex	1-25% cortex	26-75% cortex	76-100% cortex	Total
Late Preclassic	78	18	19	6	121
	64.5%	14.9%	15.7%	5.0%	6.5%
Early Classic	557	156	117	69	899
	62.0%	17.4%	13.0%	7.7%	48.4%
Late Classic	443	108	84	23	658
	67.3%	16.4%	12.8%	3.5%	48.4%

Based on data presented in Tables 16 – 18, only debitage derived from local raw materials (Table 18) yields a portion of flakes without dorsal cortex comparable to that observed in the experimentally-derived data (Table 15). The complete lack of flakes with 76-100% cortex from NBCZ sources provides a strong indication that the products

of northern Belize lithic workshops reached Blue Creek in finished form and were not accompanied by unrefined raw materials. Commodities obtained from regional source areas seem to also have arrived as finished tool forms, although a very small amount of material in unrefined form may have been brought into the Blue Creek settlement zone in the Early Classic period.

The portion of flakes from local sources that exhibit no cortex corresponds remarkably well with the Mauldin and Amick (1989) experimental biface reduction data. It should be possible to identify loci of lithic reduction at Blue Creek by focusing on the relative percentage of flakes -from local lithic resources- recovered from different settlement areas that lack cortex, as well as on the distribution of flakes with greater than 76% dorsal cortex. Areas with an exceptionally high percentage of local material debitage that lacks cortex are likely to have been net consumers of lithic goods. In contrast, areas where the percentage of flakes that exhibit 76-100% dorsal cortex exceeds the average amount of such flakes for the site as a whole are likely to have been net producers of lithic goods.

As illustrated in Table 18, the percentage of local material debitage recovered from Late Preclassic period deposits that exhibit no dorsal cortex is 64.5%, while the percentage of flakes with cortex covering 76-100% of the dorsal surface is 5.0%. Using the argument presented above, Figure 43 suggests that stone tool production is more likely to have occurred in the savannah non-elite settlement zone (N=27) based on flakes without cortex, while the distribution of flakes with 76-100% cortex -which may represent a more direct measure of manufacturing activity- suggests that lithic production was slightly more likely to have occurred within the site core (N=93). This conflicting data may be the result of the relatively small sample size of debitage recovered from Late Preclassic deposits. It should be mentioned as a caveat to Figure 43 that Savannah elite deposits produced only 0.8% (N=1) of all local resource flakes recovered and are not likely to present an accurate depiction of resource consumption. Although these relationships are intriguing, they are not statistically significant

(including savannah elite: $\chi^2 = 5.542$, $df = 6$, $p = .476$; excluding savannah elite: $\chi^2 = 4.963$, $df = 3$, $p = .175$).

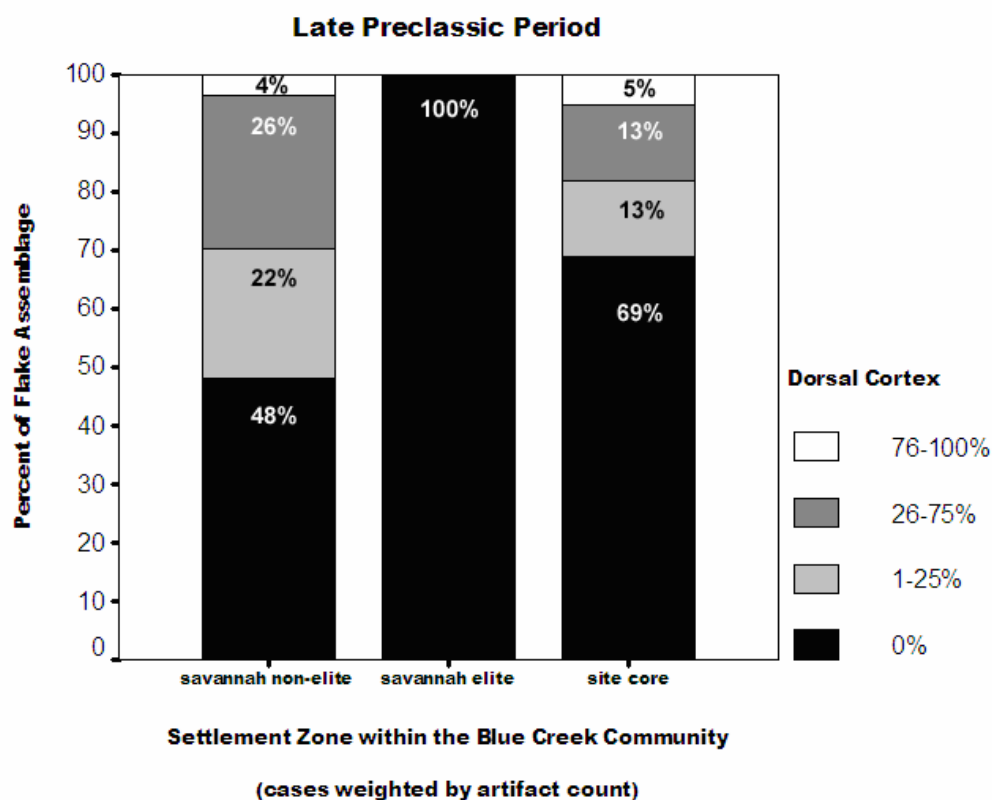


Figure 43: Amount of dorsal cortex represented on local resource debitage from Blue Creek settlement zones in Late Preclassic period deposits.

As illustrated in Table 18, the percentage of flakes recovered from Early Classic period deposits that exhibit no dorsal cortex is 62.0%, while the percentage of flakes with cortex covering 76-100% of the dorsal surface is 7.7%. Again, using the argument presented above, Figure 44 suggests that stone tool production is more likely to have occurred only among the elites of the savannah and site core based on local lithic resource debitage without cortex, while the distribution of flakes with 76-100% cortex

supports lithic production only within the site core. The suggestion that lithic manufacture was restricted to elite zones during the Early Classic period is further supported in the discussion of production failure distribution presented below. It should be mentioned as a caveat to Figure 44 that Western Group deposits produced only 0.1% (N=1) of all local resource flakes recovered and are not likely to present an accurate depiction of resource consumption. While the relationships illustrated in Figure 44 suggest that different levels of stone tool production took place among the various settlement precincts of the Blue Creek polity, the data are not statistically significant (including Western Group: $\chi^2 = 17.847$, $df = 15$, $p = .271$; excluding savannah elite: $\chi^2 = 17.222$, $df = 12$, $p = .141$).

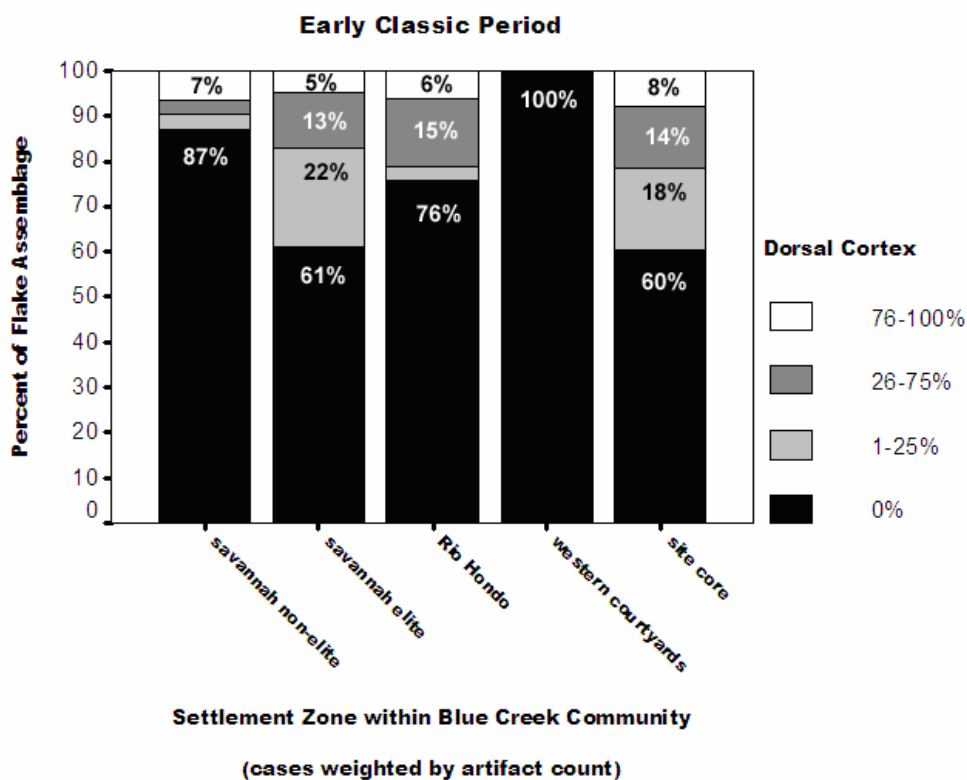


Figure 44: Amount of dorsal cortex represented on local resource debitage from Blue Creek settlement zones in Early Classic period deposits

According to Table 18, the percentage of flakes recovered from Late Classic period deposits that exhibit no dorsal cortex is 67.3%, while the percentage of flakes with cortex covering 76-100% of the dorsal surface is 3.5%. Areas with an exceptionally high percentage of local material debitage that lacks cortex are likely to have been net consumers of lithic goods. To reiterate the argument used above, areas where the percentage of flakes that exhibit 76-100% dorsal cortex exceeds the average amount of such flakes for the site as a whole are likely to have been net producers of lithic goods. The argument also states that areas with an exceptionally high percentage of local material debitage with no cortex are likely to have been net consumers of lithic goods. Using this argument, the data presented in Figure 45 suggests that stone tool production occurred in site core, Western Group, and Rio Hondo settlement zones based on flakes without cortex. The distribution of flakes with 76-100% cortex suggests that lithic production took place in both the site core and Rio Hondo settlement zones.

Lithic manufacture may not have been restricted to elite zones during the Late Classic period. The relationships illustrated in Figure 45 are statistically significant ($\chi^2 = 27.133$, $df = 15$, $p = .028$). However, while this data suggest the possibility of stone tool manufacture within the non-elite Rio Hondo settlement zone, there is little in the way of corroborating evidence to support this assertion. It may be relevant that the Rio Hondo settlement zone is situated adjacent to the river; lithic resources carried in the river channel may not have been as alienable as the terrestrial outcrops above the escarpment. Modest lithic production within the Rio Hondo settlement zone would not be an unexpected occurrence.

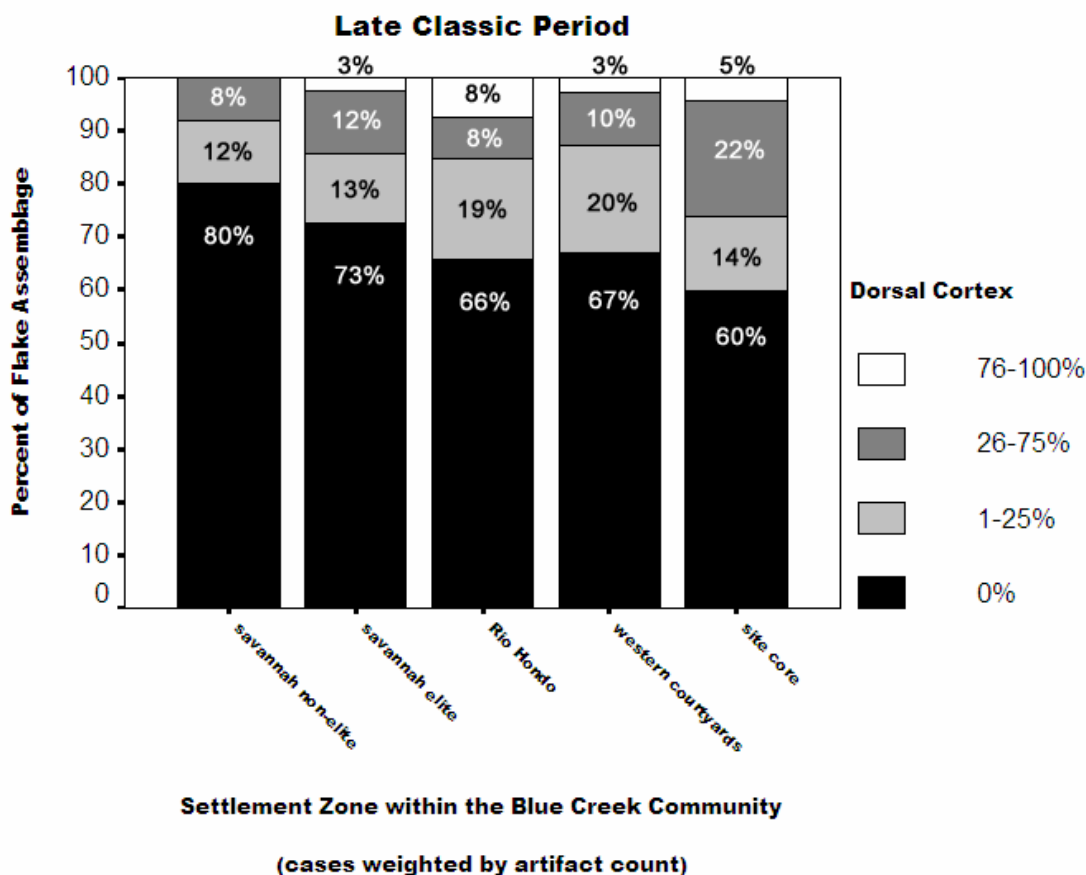


Figure 45: Amount of dorsal cortex represented on local resource debitage from Blue Creek settlement zones in Late Classic period deposits.

Production Failures

An analysis of production failures, that is, tool forms that did not reach their final production stage, is limited in its utility by issues of sample size. Only 9.0% of tools recovered in the Blue Creek settlement zone for all time periods fall into the category. Some general observations may be made, however. For example, production failures are almost entirely restricted to elite contexts during all periods except the Late Preclassic period (Figure 46). I cannot explain the high percentage of production failures in non-elite contexts below the escarpment during the Late Preclassic period given the preponderance of data which suggests that tool production did not occur within this zone at any point in time. This anomaly aside, the distribution of production failures supports the inference that tool production occurred decidedly within elite contexts.

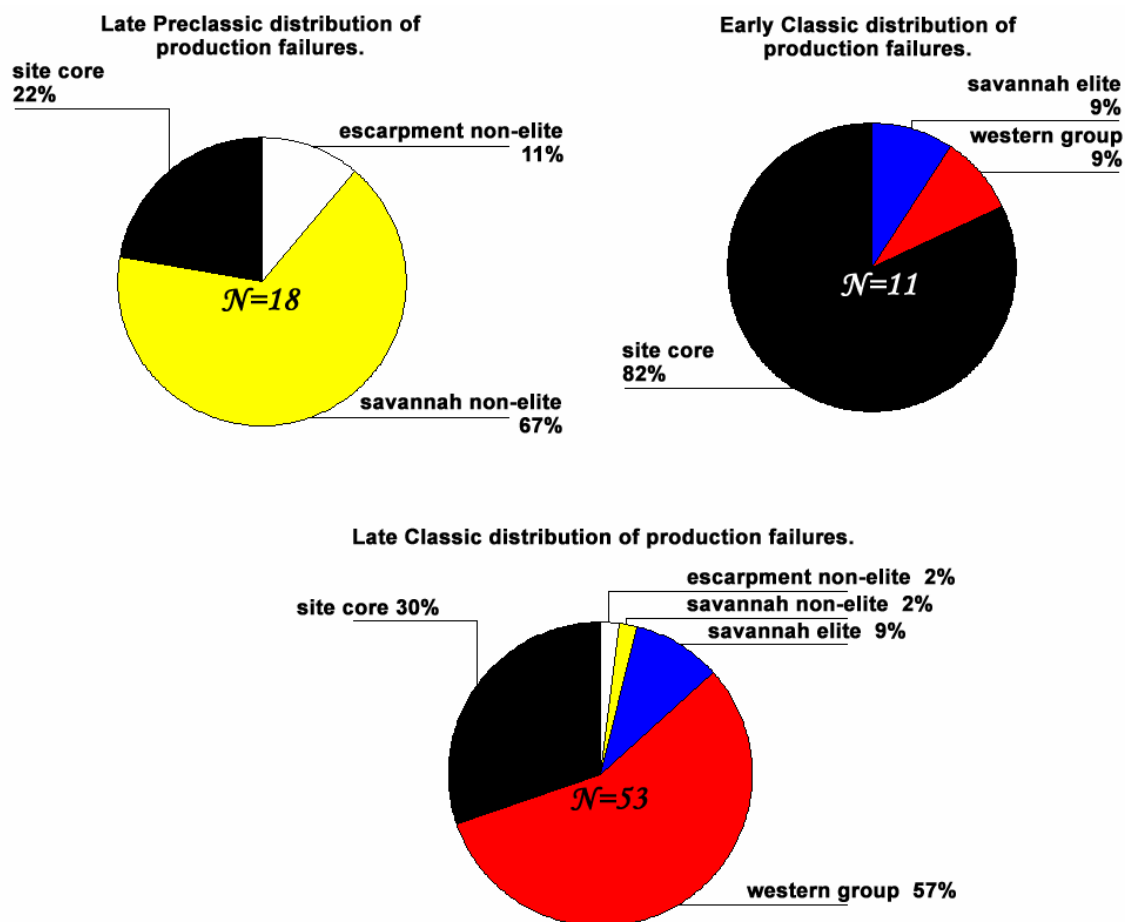


Figure 46: Distribution of production failures during various time periods.

Hammerstone Distribution

The distribution of hammerstones within the Blue Creek settlement zone offers valuable insight with regard to locating the areas of tool manufacture, but its utility is limited by sample size for all periods except the Late Classic. Only 2 hammerstones were recovered from Late Preclassic deposits, and each of these came from non-elite savannah contexts. Three hammerstones were recovered from Early Classic contexts, one each from site core, elite savannah, and non-elite savannah deposits. The paucity of hammerstones during these early periods contrasts dramatically with the 50 recovered

from Late Classic deposits. All but 3 hammerstones recovered in Late Classic period deposits came from elite contexts (Figure 47).

Two structures in particular stand out for the quantity of hammerstones they yielded. Structure U-5, an elite, vaulted structure in the savannah settlement zone, produced 13 hammerstones, while another 10 were recovered at Structure 60 in the elite residential Western Group. Structure 36 in the Western Group yielded another 5, and Structures 13 and 19 in the site core each yielded five. This distributional pattern strongly suggests that the refinement of local lithic raw materials into formal tools was an activity controlled by the elite. The likelihood that this was accomplished through attached specialization will be discussed in greater detail below.

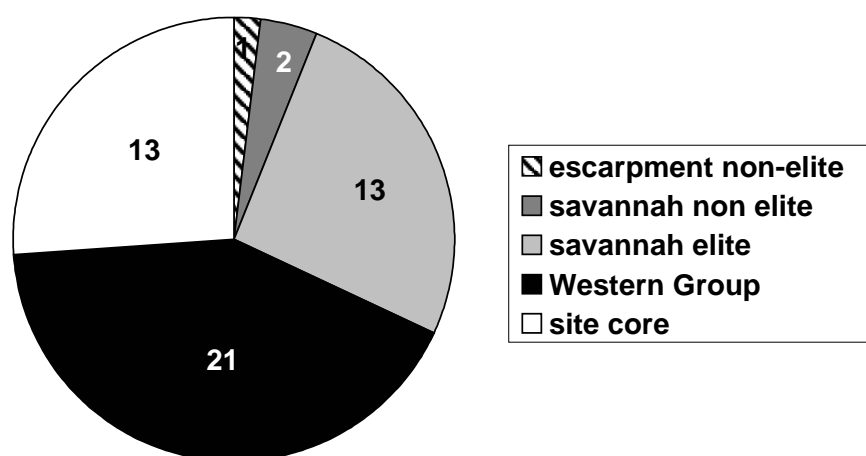


Figure 47: Late Classic period distribution of hammerstones in the Blue Creek settlement zone.

To summarize the spatial and temporal evidence for stone tool production in the Blue Creek settlement zone, I used local resource distribution, dorsal cortex representation, production failures, and the distribution of hammerstones as measures of production. Ultimately, I did not use the distribution of local resources, as reflected in the flake assemblage, as a measure of production due to the under-representation of

small-sized debitage in the assemblage. All other measures of production indicate that tool production is likely to have occurred in non-elite savannah contexts during the Late Preclassic period. Data on the occurrence of cortical flakes also lends support to production in the site core. Tool production is only likely to have occurred in and around the site core during the Early Classic period based on data derived from the distribution of production failures and cortical flakes. Hammerstone data from this period are equivocal. Each measure of production lends support to the conclusion that stone tool production occurred in the site core during the Late Classic period. Data on production failures and the distribution of hammerstones also supports the presence of tool production in the elite Western Group residential zone above the escarpment. While the distribution of hammerstones also indicates that tool production took place in elite savannah contexts, data derived from the occurrence of cortical flakes provides evidence for the occurrence of production in the Rio Hondo settlement precinct.

Based on the measures employed above, there is no compelling evidence to suggest that elites residing above the escarpment controlled stone tool production during the Preclassic period. With the exception of evidence for production in the Rio Hondo precinct, the manufacture of stone tools appears to have only been restricted to elite contexts during the Early and Late Classic periods. While this finding is consistent with expectations based on the relative representation of local raw materials in Early Classic contexts, it would not have been surprising to find that production was more evenly dispersed between elites and non-elites given the distribution of local resources in Late Classic period contexts.

Lithic Resource Conservation

Material conservation can be observed in two ways: through flake tool use and through formal tool recycling. In assessing flake tool use, I consider only flakes in size grade 1 or 2 in the analysis. Flakes in size grade 3 and 4 are often too small to present a practical tool or core, and their incorporation would necessarily skew observations of potential material use. Thus, their exclusion directs the analysis toward considering only

those flakes which could conceivably have been used. I then use the lack of edge modification as a measure of material waste. Formal tool recycling represents a less sensitive measure of material conservation because most tools can be expected to have been rejuvenated at some point during their life cycle. For example, I found that 52.4% of tools from all time periods for which stage of manufacture could be assessed had been recycled. Only 9.0% of all tools recovered had not reached the final stages of production. I consider flake tool use as a stronger indication of material conservation and/or waste because it appears to represent this relationship with greater accuracy. Furthermore, I found no statistically significant relationships in analyzing the percentage of recycled tools among Blue Creek's various settlement precincts through time (Table 19).

Table 19: Percentage of recycled tool forms by settlement zone through time.

Settlement Zone	Middle Preclassic	Late Preclassic	Early Classic	Late Classic
escarpment non-elite	-	0 / 3	3 / 5	6 / 13
	-	0.0%	60.0%	46.2%
Savannah non-elite	2 / 5	42 / 84	8 / 11	12 / 27
	40.0%	50.0%	72.7%	44.4%
Savannah elite	-	-	39 / 59	53 / 104
	-	-	66.1%	51.0%
Rio Hondo	-	-	10 / 16	30 / 49
	-	-	62.5%	61.2%
Western Group	-	-	-	159 / 325
	-	-	-	48.9%
Site Core	8 / 20	27 / 61	43 / 76	91 / 175
	40.0%	44.3%	56.6%	52.0%
Blue Creek Community	10 / 25	69 / 148	103 / 167	351 / 693
	40.0%	46.6%	61.7%	50.6%
χ^2	.000	3.142	1.90	3.23
df	1	2	4	5
p =	1.000	.208	.754	.664

Interestingly, a relatively high degree of material conservation is observed during the Middle Preclassic period at Blue Creek, when 30% of all flakes (in size grade 1 or 2) exhibit edge modification (Table 20). This measure may be skewed due to sample size limitations, but it seems to suggest that lithic resources were valued as scarce commodities during this early period.

Only 19.4% of flakes in size grade 1 or 2 from Late Preclassic period contexts exhibited edge modification, though there is a striking contrast observed between non-elite savannah contexts (33.3%, $n=27$) and elite contexts above the escarpment (10.3%, $n=39$) (Table 20). Tool forms are commonly found in a recycled state during the Late Preclassic period, when 46.6% of all tool forms recovered had been refurbished. There is no statistically significant difference between the site core elite (44.3% curated) and the savannah non-elite (50.0% curated) contexts in this regard (Table 19).

Informal and expedient tool use falls dramatically during the Early Classic period. Only 6.2% of all flakes in size grade 1 or 2 exhibit edge modification (Table 20). The most striking contrast is observed between contexts located above and below the escarpment, regardless of socio-economic status. Among elites in the savannah settlement zone, 18.8% of flakes exhibited edge modification, and likewise flake use among non-elites in the savannah settlement zone was at 18.2%. Flake tool use within the decidedly non-elite Rio Hondo community was 37.9%. This high level of informal tool use among settlements below the escarpment is in sharp contrast to the 1.0% observed within the site core during the Early Classic period. Less differentiation is observed when comparing the percentage of recycled formal tools (Table 19), and differences are not statistically significant. Of all formal tools recovered in excavations in the Blue Creek site core, 55.7% were determined to have been recycled forms. This compares rather favorably to other settlement zones such as savannah non-elite settlements where 72.7% of tools were determined to have been recycled, savannah elite settlement where 66.1% of tools were recycled, and the Rio Hondo settlement where 62.5% of formal tools were recycled. On average, 61.7% of all formal tools recovered during the Early Classic period were observed to have been recycled. The lower

percentage of curated tools in elite contexts above the escarpment may be influenced by the increased frequency of unused or little-used tools that were included in cache deposits in these contexts.

Table 20: Percentage of flakes (size grade 1 or 2) exhibiting edge modification by settlement zone.

Settlement Zone	Middle Preclassic	Late Preclassic	Early Classic	Late Classic
Savannah non-elite	4 / 13	9 / 27	2 / 11	3 / 9
	30.8%	33.3%	18.2%	33.3%
Savannah elite	-	0 / 1	24 / 128	53 / 189
	NA	0.0%	18.8%	28.0%
Rio Hondo	-	-	11 / 29	21 / 86
	NA	NA	37.9%	24.4%
Western Group	-	-	0 / 1	13 / 219
	NA	NA	0.0%	5.9%
Site Core	8 / 27	4 / 39	5 / 511	27 / 141
	29.6%	10.3%	1.0%	19.1%
Blue Creek Community	12 / 40	13 / 67	42 / 681	118 / 649
	30.0%	19.4%	6.2%	18.2%
χ^2	.005	5.68	112.23	38.17
df	1	2	5	5
p =	0.941	0.058	0.000	0.000

The Late Classic period lithic assemblage contrasts dramatically with the Early Classic period assemblage, providing evidence that the Blue Creek community, with the exception of residents of the elite Western Group, became much more concerned with conserving raw materials. Informal and expedient tool use rose from 6.2% during the Early Classic period to 18.2% during the Late Classic period (Table 20). Flake tool use rose in the site core from 1.0% during the Early Classic period to 19.1% during the Late Classic period, though this may have resulted from the radical transformation of much of the site core from ceremonial to residential space at this time (Driver 2002; Driver, et al. 1997). In fact, the Western Group is the only settlement area in the Late Classic period without a significant presence of informal or expedient tools. Arguably, the Western Group represents the only true area of opulence in the Blue Creek community during the

Late Classic period, and it is possible that the residents of this zone were comparatively immune to the resource concerns that appear to have been manifest throughout the rest of the polity.

The degree of lithic resource conservation throughout the site is nearly equivalent for the Late Preclassic and Late Classic periods. The Early Classic period, however, represents an anomalous era when resource waste reached an extraordinary level. Measured through the expansion and innovation of elite architectural programs (Driver 2002; Guderjan, et al. 1996; Guderjan, et al. 2003) and the quantity of jade imported (Guderjan 2002), Blue Creek's relative opulence during this period is likely to explain this pattern. Following the marked decline in the site's fortunes at the close of the sixth century, conservation returned to what may be considered normal or expected levels. It may be significant, however, that site core contexts exhibit nearly twice the level of resource conservation in the Late Classic period as was observed during the Late Preclassic. The available data is not conclusive as to whether this signifies a decline in the status and economic capability of site core residents, or if it is simply a reflection of the site core's functional transition.

Testing Research Hypotheses

Four research hypotheses were outlined in the opening chapter of this dissertation. The goal of these hypotheses is to test whether utilitarian lithic resources were strategically important in determining the structure of Maya society at Blue Creek. Lithic resources were a critical resource for the ancient Maya, and these resources were scarce and thereby alienable in the Blue Creek settlement zone. Thus, the critical issues concern whether or not these resources were monopolized by any group, and whether or not that monopoly provided that group with an economic advantage over other groups. This relationship must be established prior to more theoretical discussions concerning the legitimizing mechanisms of resource monopolies, the means used to maintain resource alienation, and the economic processes by which preferential access to strategic resources is converted into greater levels of power, prestige, and wealth.

Hypothesis One

The first hypothesis states that proximity to local lithic resource outcrops serves as a reliable indicator of the relative consumption of those resources. The distribution of quality lithic resources across the Blue Creek settlement zone is uneven, and favors contexts located above the escarpment. Differential resource entitlements between groups within the community should be represented by disparities in the relative distribution of local resources between settlement contexts. I emphasize relative distribution rather than absolute distribution because functional differences in antiquity could have influenced the actual volume of material present within any given context. Excavation biases are also likely to have volumetrically over-represented some areas with respect to others. The relationship of interest is that of material preference, and I assume that local materials would be preferred over imports in utilitarian contexts because exotic goods would have required an investment of resources to obtain. I use the following *consumption index* to measure the relative representation of local lithic resources among various settlement contexts at Blue Creek:

$$(([\text{N tools L} / \text{N tools T}] + [\text{W tools L} / \text{W tools T}]) / 2 + [\text{W flakes L} / \text{W flakes T}]) / 2$$

(where N=number, L=local, T=total, W=weight)

This index calculates the ratio of tools crafted from local materials by weight and by count, averaging these ratios to reach a figure that represents the relative importance of local materials within the formal tool assemblage. Next it calculates the ratio of local lithic resources among the flake assemblage. Since the percentage of local resources present within the flake and formal tool assemblages for all settlement localities are each taken to be an important reflection of resource utilization, the *consumption index* averages the two ratios to produce a final assessment of local resource representation.

Table 21 documents the linear distance observed between settlement zones within the Blue Creek community and the local, regional, and exotic lithic resource outcrops. Figures for areas examined in the text within the *bajo* region 12km west of Blue Creek (likely affiliated with the site of Bedrock) are also provided. According to the proximity hypothesis, the relative proportion of local resources should be higher in deposits that are located closer to natural local lithic outcrops. Again, there would be a more equal distribution of such resources across the settlement zone if local utilitarian lithic resources were freely accessible to all members of the community. This comparison of the geographic proximity of resources and relative level of their consumption is important for two reasons. First, it illustrates the spatial variability in resource use across the settlement zone. Secondly, it demonstrates the extent to which proximity to a resource node influenced the intensity of its access. If a comparable level of local resource consumption reflects similar use-rights, given comparable needs, then significant contrasts in the level of consumption would imply that not all households had equivalent entitlements.

Greater proximity to lithic resource outcrops does not in itself provide a direct measure of access or control. In the case of systems of wealth finance (Earle 1989), attached specialists may reside near a resource for the purpose of exploiting it, but the level of exploitation and the fruits of their labor are controlled by an administrative elite. In this instance, proximity to and exploitation of the resource are an inaccurate measure of control. I do not assume that the *consumption index* alone is a measure of resource control, but it is simply a measure of how resource proximity influences its relative utilization. The index value for settlement zones within the Blue Creek community are provided in Table 22 organized by time period.

Table 21: Approximate average distance measurements (in kilometers) between known resource nodes and settlement areas mentioned in the text.

Settlement Zones at Blue Creek			Escarpment non-elite	Savannah non-elite	Savannah elite	Rio Hondo	Western Group	Site core	Bajo Settlement Zone		
									Bedrock courtyard	Sotohob courtyard	Bedrock workshop
Lithic Raw Material Resource Zones	Indeterminate		-	-	-	-	-	-	-	-	-
	Local	Rio Azul (river)	5	4	4	1	4	5	12	11	12
		Escarpment face and base	3	1	1	2	1	1	13	12	13
		North Rosita corridor	3	4	4	6	3	4	10	8	10
		South Rosita corridor	1	5	5	8	3	3	11	10	11
		General Rosita corridor	2	5	5	7	3	3	10	9	10
	Regional	North <i>bajo</i> corridor	15	17	17	17	15	16	3	5	3
		South <i>bajo</i> corridor	10	12	12	14	11	11	1	2	1
		General <i>bajo</i> corridor	10	14	14	15	12	12	3	3	3
		Northwest <i>bajo</i>	18	21	21	22	19	19	7	8	7
		Cool Shade Farm	16	18	18	20	17	17	5	6	5
	Exotic	Northern Belize chert zone	60	60	60	60	60	60	70	70	70
		Exotic unknown	-	-	-	-	-	-	-	-	-
		Honeycamp Lagoon	75	75	75	75	75	75	85	85	85
		Progreso Lagoon	75	75	75	75	75	75	85	85	85
		Northern Belize lagoons	75	75	75	75	75	75	85	85	85

Measurements recorded are linear measures of distance and do not account for the topographic variability or permeability of different landscapes. The Rio Bravo escarpment would have presented a significant obstacle for exploiting upland resources to residents living below the escarpment.

Table 22: Consumption index values for Blue Creek communities during various time periods.

Settlement Zone	Consumption Index Computation	
	calculation	index value
Middle Preclassic		
savannah non-elite	$((0 / 5) + (0 / 110)) / 2 + (214 / 489) = / 2$	21.9
site core	$((1 / 15) + (44 / 612)) / 2 + (457 / 899) = / 2$	28.9
Late Preclassic		
savannah non-elite	$((10 / 72) + (1526 / 4194)) / 2 + (178 / 826) = / 2$	23.4
site core	$((8 / 58) + (638 / 3003)) / 2 + (653 / 1095) = / 2$	31.3
Early Classic		
savannah non-elite	$((8 / 58) + (638 / 3003)) / 2 + (653 / 1095) = / 2$	31.3
savannah elite	$((5 / 62) + (892 / 6026)) / 2 + (1072 / 3318) = / 2$	21.9
Rio Hondo	$((5 / 15) + (186 / 694)) / 2 + (302 / 541) = / 2$	43.0
site core	$((16 / 72) + (1752 / 6802)) / 2 + (9869 / 10,143) = / 2$	60.7
Late Classic		
escarpment non-elite	$((2 / 5) + (182 / 348)) / 2 + (124 / 124) = / 2$	73.1
savannah non-elite	$((3 / 29) + (266 / 4594)) / 2 + (95 / 236) = / 2$	24.2
savannah elite	$((16 / 81) + (2334 / 8816)) / 2 + (1721 / 3977) = / 2$	33.2
Rio Hondo	$((23 / 39) + (1776 / 2238)) / 2 + (910 / 1256) = / 2$	71.1
Western Group	$((39 / 263) + (5516 / 29,714)) / 2 + (2892 / 5227) = / 2$	36.0
site core	$((31 / 152) + (6868 / 18,224)) / 2 + (1439 / 2928) = / 2$	39.1

Table 22 shows that upland contexts yield a consistently higher index value than contexts below the escarpment. This illustrates the point that upland contexts -which were closer to resource outcrops than settlement zones below the escarpment- were far more likely to utilize local lithic materials. The disparity in local material utilization is moderate and shows appreciable differences between the Middle and Late Preclassic periods, however it becomes decidedly more pronounced during the Early Classic period. The high levels of local resource use in the Rio Hondo settlement zone are an intriguing anomaly to this pattern. However, it is likely that residents of this area were procuring lithic resources from river deposits.

The high index value for non-elite architecture above the escarpment during the Late Classic period is also interesting. This suggests that proximity to resources was a major determinant of their distribution, though this may only hold true for the Late Classic period. There are no comparable non-elite deposits above the escarpment from earlier time periods. However, as there is no evidence for socio-economic stratification

during the Middle Preclassic period, site core deposits during this early time period may be considered non-elite. Given this allowance, contexts above the escarpment are likely to have exhibited a greater proportional use of local lithic materials throughout the occupation history of the Blue Creek polity.

Based on flake analysis, the distribution of local lithic resources throughout the Blue Creek community between settlement contexts located above and below the escarpment is statistically significant at the 99% confidence interval for all time periods (Table 23). There is no statistically significant relationship in the distribution of tool forms crafted from local raw materials during the Preclassic, and only approaches significance during the Early Classic period at the 90% confidence interval (Table 24). This suggests that while access to, and processing of, local raw materials was dependent on proximity to the resource during these periods, consumption was not. This is an intriguing, but not surprising finding, given that many commodities were probably attained through markets rather than direct procurement. The amount of resources that one was required to invest to attain a tool may have depended on the form of the tool, what source area it emanated from, and various raw material properties. The choice of which commodity to invest in may have depended as much on its realized cost as it did on the form of the tool, how recyclable the raw material was, and other cultural perceptions of value. Thus, archaeologically observed patterns of resource consumption are likely to reflect (if ambiguously) dynamic decision processes, and are not likely to be easily reduced to equations of direct cost and resource proximity.

The above hypothesis, that proximity to raw material outcrops serves as a reliable predictor of the proportional consumption of those resources, is not supported for all time periods through statistical analysis of the Blue Creek lithic data. Also, there are significant disparities in the representation of local raw materials among the debitage and formal tool assemblages. While proximity to raw material outcrops does appear to affect the distribution of local lithic resources based on the flake assemblage for all time periods, analysis of the formal tool assemblage suggests that this relationship was only significant during the Classic period. While there is no consistent correlation between

resource proximity and proportional resource use based on the distribution of formal tools, there does appear to be some correlation between economic status and raw material choice among formal tools during the Late Classic period, primarily due to tools from the FGB source area being recovered almost exclusively in elite contexts (Table 25).

Table 23: Comparative distribution of lithic resources throughout the Blue Creek settlement zone based on the analysis of debitage recovered in settlement contexts located above and below the Rio Bravo escarpment

Context		Lithic Raw Material Source Area					χ^2		
Period	Settlement Zone	local	regional	NBCZ	FGB	total	value	df	p
Middle Preclassic	above escarpment	164	121	0	0	285	18.140	2	.000
	below escarpment	15	17	2	0	34			
Late Preclassic	above escarpment	93	124	2	0	219	82.083	2	.000
	below escarpment	28	128	53	0	209			
Early Classic	above escarpment	771	30	0	0	801	531.132	2	.000
	below escarpment	128	149	83	0	360			
Late Classic	above escarpment	350	344	24	0	718	36.414	3	.000
	below escarpment	308	194	53	1	556			

Table 24: Comparative distribution of lithic resources throughout the Blue Creek settlement zone based on the analysis of formal tools recovered in settlement contexts located above and below the Rio Bravo escarpment.

Context		Lithic Raw Material Source Area					χ^2		
Period	Settlement Zone	local	regional	NBCZ	FGB	total	value	df	p
Middle Preclassic	above escarpment	1	12	4	0	17	.742	2	.690
	below escarpment	0	3	2	0	5			
Late Preclassic	above escarpment	8	26	26	0	60	.009	2	.996
	below escarpment	10	31	31	0	72			
Early Classic	above escarpment	18	37	25	0	80	5.771	2	.056
	below escarpment	11	37	43	0	91			
Late Classic	above escarpment	73	233	67	49	422	21.390	3	.000
	below escarpment	42	59	39	9	149			

Table 25: Comparative distribution of lithic resources throughout the Blue Creek settlement zone based on the analysis of formal tools recovered in elite and non-elite settlement contexts.

Context		Lithic Raw Material Source Area					χ^2		
Period	Economic Status	local	regional	NBCZ	FGB	total	value	df	p
Middle Preclassic	non-elite	0	3	2	0	5	.742	2	.690
	elite	1	12	4	0	17			
Late Preclassic	non-elite	10	31	31	0	72	.009	2	.996
	elite	8	26	26	0	60			
Early Classic	non-elite	8	12	11	0	31	2.105	2	.349
	elite	21	62	57	0	140			
Late Classic	non-elite	29	21	22	2	74	34.291	3	.000
	elite	86	271	84	56	497			

Hypothesis Two

The second hypothesis states that settlement zones that exhibit a lower relative level of local lithic resource consumption will also exhibit a relatively greater amount of local resource conservation. As has been observed elsewhere (McAnany 1989b), lithic resource scarcity is often correlated with greater conservation in the form of intensive recycling. The documentation of such patterns between sites has been instrumental in the development of producer-consumer models for lithics. Dependency relationships within sites should also be visible by studying variation in levels of material conservation between settlement zones. Where unrestricted access to local utilitarian lithic resources was not an endowed right, higher levels of material conservation should be expected because procurement of this material would have come with a realized cost.

I assess the degree of local material conservation here by combining two measurements. For the first measure of conservation, I calculate the ratio of productive lithic waste that exhibits edge modification to the total productive waste present. I regard flakes in size grades 1 (1-inch mesh) or 2 (3/4-inch mesh) as having enough material mass to have been crafted into expedient tools, and therefore consider them “productive lithic waste.” For the second conservation measurement, I calculate the degree to which formal tools were recycled to an optimum level. This measure is similar in premise to the “curation rate” concept proposed by Shott (1989). I regard formal tool curation as optimal when tool forms were used to exhaustion. I recorded formal tools as having been used to exhaustion once they reached the end of their use-life as either a formal tool or core. I judged this point to have been reached when further recycling became either impractical or unfeasible. I calculated the following *conservation index* by time period for each settlement zone. The index formula combines the ratio of modified flakes with that of exhausted tool forms as follows:

$$\frac{((\text{modified flakes} / \text{total flakes}) + (\text{exhausted tools} / \text{total tools}))}{2}$$

(note that only tools and flakes of local raw material are included in the calculation)

This *conservation index* is designed to measure the degree of actual consumption as a percentage of total potential consumption. The formula is somewhat crude and cannot account for functional differences between contexts that may account for higher levels of informal tool use. Also, not all flakes in size grade 1 or 2 would have been suitable for expedient tool use. Regardless of these caveats, I regard the *consumption index* as an adequate relative measure of material use patterns at Blue Creek. Table 26 presents calculations of the *conservation index* for settlement zones within the Blue Creek community by time period:

Table 26: Conservation index values for Blue Creek communities during various time periods.

Settlement Zone	Conservation Index Computation	
Middle Preclassic	calculation	index value
savannah non-elite	$((4/13) + (3/6)) / 2$	40.4
site core	$((8/27) + (10/20)) / 2$	39.8
Late Preclassic		
savannah non-elite	$((9/27) + (41/104)) / 2$	36.4
site core	$((4/37) + (28/71)) / 2$	25.1
Early Classic		
savannah non-elite	$((2/11) + (5/18)) / 2$	23.0
savannah elite	$((24/128) + (24/67)) / 2$	27.3
Rio Hondo	$((11/29) + (6/21)) / 2$	33.3
site core	$((5/511) + (32/92)) / 2$	17.9
Late Classic		
escarpment non-elite	$((1/5) + (2/15)) / 2$	16.7
savannah non-elite	$((3/9) + (8/30)) / 2$	30.0
savannah elite	$((53/189) + (43/104)) / 2$	34.7
Rio Hondo	$((21/86) + (20/59)) / 2$	29.2
Western Group	$((13/219) + (124/317)) / 2$	22.6
site core	$((27/141) + (65/177)) / 2$	27.9

The second method used to compare the degree of material conservation in different settlement contexts at Blue Creek examines the percentage of all stone tools recovered from each zone that can be characterized as expedient. I measure the relative reliance on informal or expedient tool forms through calculation of an *expedience index* using the following formula:

(N expedient or informal tools / N all tool forms)

Note that the formula only includes tool forms crafted from local raw materials

The *expedience index* simply calculates the ratio of expedient or informal tool forms to the complete tool assemblage recovered from a given archaeological context. All flakes in size grade 1 or 2 that exhibit edge modification are included as expedient tool forms.

Greater levels of lithic material conservation can be expected where these materials are scarce (Bamforth 1986) or where their procurement is associated with a realized investment of resources. Conservation is likely to occur in proportion to the relative cost of material replacement, and this cost will depend on the value of an individual's exchange entitlements (Sen 1992). Where the *conservation index* measures the efficiency of resource consumption by focusing on the proportion of flakes that exhibit edge modification, the *expedience index* addresses conservation by emphasizing the number of informal tools recovered relative to formal tools. This tracks conservation by showing the reliance on flake tools in the context of total tool usage.

Kelly (1988:719) has suggested that formal bifaces offer a more efficient way to store raw materials because they “maximize the total amount of stone cutting edge while minimizing the amount of stone carried.” While this is indeed an important consideration for the mobile foragers studied by Kelly, the Maya present a far different scenario. As sedentary agriculturalists, decisions governing the use of formal vs. expedient tools were likely to have been primarily based on task requirements; storage and portability are less critical concerns. However, there also existed numerous activities for which either technological system would have been suitable. Bifaces are more durable than expedient tool forms and offer a greater capacity for continued maintenance (Bleed 1986), thus they are a more efficient use of raw materials (Kelly 1988). Among sedentary groups in particular, biface-dominated assemblages do not denote resource use at its optimum level of efficiency. The waste produced from biface manufacture can be utilized in an expedient fashion, thereby alleviating the burden placed on formal tools and extending their use life. Thus, a greater proportional use of expedient tool forms relative to formal bifaces in any of the settlement zones throughout

the Blue Creek community is likely to indicate higher overall levels of material conservation, which may in turn relate to disparities in lithic resource use-rights. The expedience index value for settlement zones in the Blue Creek community are provided in Table 27 by time period.

Table 27: Expedience index values for Blue Creek communities during various time periods.

Settlement Zone	Expedience Index Computation	
Middle Preclassic	calculation	index value
savannah non-elite	4 / (5 + 4)	36.4
site core	8 / (15 + 8)	34.8
Late Preclassic		
savannah non-elite	9 / (72 + 9)	11.1
site core	4 / (55 + 4)	6.8
Early Classic		
savannah non-elite	2 / (11 + 2)	15.4
savannah elite	24 / (58 + 24)	29.3
Rio Hondo	11 / (16 + 11)	40.7
site core	5 / (61 + 5)	7.6
Late Classic		
escarpment non-elite	1 / (12 + 1)	7.7
savannah non-elite	3 / (26 + 3)	10.3
savannah elite	53 / (99 + 53)	34.9
Rio Hondo	21 / (49 + 21)	30.0
Western Group	13 / (295 + 13)	4.2
site core	27 / (159 + 27)	14.5

The obvious problem with the use of either the *conservation index* or the *expedience index* is that functional differences between areas may have more influence over the composition of assemblages than entitlement variability. However, much of the lithic assemblage was recovered from domestic contexts where there is expected to be a significant degree of task redundancy. Construction fill contexts may be less comparable as the use-context of such materials cannot be ascertained. Still, such fill is likely to have been incorporated from nearby domestic waste deposits, and thus to have been related to domestic activities that were reproduced at various scales at all organizational levels.

Table 28: Middle Preclassic period consumption, conservation, and expedience index comparisons among settlement precincts.

Settlement Zone	Location	Consumption Index	Conservation Index	Expedience Index
Savannah non-elite	below escarpment	21.9	40.4	36.4
Site core	above escarpment	28.9	39.8	34.8

The second hypothesis, that settlement zones with lower local resource consumption will also exhibit greater conservation of local resources, cannot be rejected based on Middle Preclassic period lithic data (Table 28). Higher *conservation* and *expedience index* values are found with a lower *consumption index* value. However, the variation in index values is not great and the resulting pattern is only tenuous. The utility of the *expedience index* is particularly suspect due to sample size limitations for this early period.

Table 29: Late Preclassic period consumption, conservation, and expedience index comparisons among settlement precincts.

Settlement Zone	Location	Consumption Index	Conservation Index	Expedience Index
Savannah non-elite	below escarpment	23.4	36.4	11.1
Site core	above escarpment	31.1	25.1	6.8

The second hypothesis also cannot be rejected based on Late Preclassic period lithic data (Table 29). Higher conservation and expedience index values are again found with a lower consumption index value in the savannah non-elite versus the site core elite. In this instance, however, the variation in index values is more dramatic and the resulting relationship is supported more securely.

Table 30: Early Classic period consumption, conservation, and expedience index comparisons among settlement precincts.

Settlement Zone	Location	Consumption Index	Conservation Index	Expedience Index
Savannah non-elite	below escarpment	21.8	23.0	15.4
Savannah elite	below escarpment	21.9	27.3	29.3
Rio Hondo	below escarpment	43.0	33.3	40.7
Site core	above escarpment	60.7	17.9	7.6

As with the Preclassic, the second hypothesis cannot be rejected based on lithic data from Early Classic period deposits (Table 30). Higher *conservation* and *expedience index* values are once again found in context with a lower *consumption index* value. The variation in *expedience index* values observed between contexts is particularly interesting. While the Rio Hondo precinct has a relatively high index of local lithic resource consumption, the index of conservation there is the highest observed anywhere in the Blue Creek polity. This suggests that local raw material was either not easily attained by residents of the Rio Hondo community, or that the realized cost of procuring lithic resources was high.

Interestingly, the elites of the savannah settlement zone exhibit a higher incidence of material conservation than non-elites within that zone. This could simply reflect the fact that the index values for non-elites from the savannah settlement zone were based on a small sample size (11 flakes, 18 formal tools) relative to that of the more elite residences (128 flakes, 67 formal tools).

There is a slight decrease in material conservation among the elite residents of the site core from the Late Preclassic period to the Early Classic. There is also a significant increase in the proportional representation of local lithic resources. This suggests that access to local raw materials by elites residing above the escarpment was significantly different from that experienced by other settlement zones within the Blue

Creek polity. If the proportional representation of local raw materials is in fact related to resource use-rights, elites realized an unparalleled monopoly over local lithic resources during the Early Classic period.

Table 31: Late Classic period consumption, conservation, and expedience index comparisons among settlement precincts.

Settlement Zone	Location	Consumption Index	Conservation Index	Expedience Index
Escarpment non-elite	above escarpment	73.1	16.7	7.7
Savannah non-elite	below escarpment	24.2	30.0	10.3
Savannah elite	below escarpment	33.2	34.7	34.9
Rio Hondo	below escarpment	71.1	29.2	30.0
Western Group	above escarpment	36.0	22.6	4.2
Site core	above escarpment	39.1	27.9	14.5

In contrast to earlier periods, the hypothesis is not supported by lithic data from Late Classic period deposits (Table 31). Higher relative rates of material conservation and use of expedient tool forms are not consistently found in contexts having a lower rate of local resource consumption. Higher levels of local resource consumption no longer appear to be associated with elite contexts, nor are they well correlated with linear distance from the raw material outcrops. However, distance from resource outcrops becomes more relevant if the Rio Hondo precinct is either removed from the equation, or that precinct's proximity to a viable procurement node is reevaluated. As mentioned earlier, the Rio Hondo settlement zone lays adjacent to a river that may have furnished lithic raw materials. If this were the case, and if proximity to a resource does influence use-rights, elites residing above the escarpment are not likely to have had the authority to alienate communities below the escarpment from riverine resources.

Hypothesis Three

The third research hypothesis states that evidence for the production of stone tools will be observed more frequently in areas that exhibit greater relative consumption of local lithic resources. A method for measuring the relative consumption of local resources has been illustrated above: the *consumption index*. Here, I calculate the relative occurrence of stone tool production from the ratio of the number of tool forms in initial, early, or late production stages to the total number of tools recovered from each context. This ratio, referred to as the *production index*, is calculated using the formula,

$$(N \text{ tools in production stages 1-3} / N \text{ tools in production stages 1-5})$$

Note that only includes tools crafted from local raw materials

The criteria used for assessing the production stage of formal tools were discussed in Chapter V of this volume. Although debitage with greater than 25% dorsal cortex can also provide an indication of lithic reduction activities, it is a more indirect measure and interjects some ambiguity into the analysis (although flakes with 76-100% dorsal cortex are a decidedly less ambiguous indication of tool production). Thus, I focus here on production discards and preforms to the exclusion of other methods of quantifying manufacturing activity because they provide direct measures of such actions. Earlier in this chapter I discussed measures of production that focus on both the presence of flakes that exhibit dorsal cortex and the percentage of flakes devoid of dorsal cortex, as well as the distribution of hammerstones. I use those data here in a corroborative fashion, but do not include them in calculating the *production index*. The *production index* for settlement zones in the Blue Creek community are provided in Table 32 by time period:

Table 32: Production index values for Blue Creek communities during various time periods.

Settlement Zone	Production Index Computation	
	calculation	index value
Middle Preclassic		
savannah non-elite	0 / 5	0.0
site core	2 / 17	11.8
Late Preclassic		
escarpment non-elite	2 / 3	66.7
savannah non-elite	12 / 84	14.3
site core	4 / 59	6.8
Early Classic		
escarpment non-elite	0 / 5	0.0
savannah non-elite	0 / 11	0.0
savannah elite	1 / 59	1.7
Rio Hondo	0 / 16	0.0
Western Group	1 / 6	16.7
site core	9 / 70	12.9
Late Classic		
escarpment non-elite	1 / 13	7.7
savannah non-elite	1 / 27	3.7
savannah elite	5 / 104	4.8
Rio Hondo	0 / 49	0.0
Western Group	30 / 325	9.2
site core	16 / 175	9.1

It is important to consider that the presence or absence of tool forms manufactured from local materials does not constitute an accurate measure of direct resource entitlement due to the likelihood that stone tools were acquired through either market exchange systems or reciprocal relationships rather than through direct procurement. While the presence of production-related debris and preforms is generally considered a more accurate reflection of direct entitlement, production debris may identify the activities of a craft specialist who has little or no administrative control over the resource. Craft specialists attached to elite households may receive few of the economic benefits enjoyed by those with administrative control of the resource, and so their apparent access to these resources, whether measured in volume of production debris or proximity to the resource node, is a poor proxy measure of the relationship between entitlement and social stratification.

Table 33: Middle Preclassic period consumption and production index comparisons among settlement precincts.

Settlement Zone	Location	Consumption Index	Production Index
Savannah non-elite	below escarpment	21.9	0.0
Site core	above escarpment	28.9	11.8

The third hypothesis cannot be rejected based on consumption and production indexes for lithic data recovered from Middle Preclassic deposits (Table 33). However, sample size limitations for materials recovered during this early period limit the certainty with which an argument can be made for higher levels of production in areas closer to resource outcrops. A consideration of the percentage of flakes with greater than 76% dorsal cortex cannot provide an ancillary measure of production for this period because sample sizes are too small for statistical comparisons.

Table 34: Late Preclassic period consumption and production index comparisons among settlement precincts.

Settlement Zone	Location	Consumption Index	Production Index
Savannah non-elite	below escarpment	23.4	14.3
Site core	above escarpment	31.1	6.8

The third hypothesis is not supported by the Late Preclassic lithic assemblage, as shown in Table 34. While contexts above the escarpment exhibit higher levels of local raw material consumption during this period, contexts below the escarpment have a higher relative (and actual) number of preforms. When the data provided earlier in this chapter on the distribution of flakes from local resources with greater than 25% dorsal cortex is considered as an ancillary measure of lithic manufacture (see Figure 43), stone tool production is much more strongly supported in contexts below the escarpment

during the Late Preclassic period. Given this, it may be relevant that the only hammerstones recovered in Late Preclassic period deposits came from non-elite contexts in the savannah zone.

Table 35: Early Classic period consumption and production index comparisons among settlement precincts.

Settlement Zone	Location	Consumption Index	Production Index
Savannah non-elite	below escarpment	21.8	0.0
Savannah elite	below escarpment	21.9	1.7
Rio Hondo	below escarpment	43.0	0.0
Site core	above escarpment	60.7	12.9

The third hypothesis is tenuously supported based on consumption and production indices for lithic data recovered from Early Classic period deposits, as described in Table 35. The Rio Hondo community exhibits a high proportional use of local resources, but no preforms or production failures were recovered from this zone. However, data discussed earlier in this chapter shows this zone to have the second highest proportion of flakes with greater than 25% cortex, only slightly less than is recorded in contexts above the escarpment. The absence of preforms and production failures in the Rio Hondo precinct may relate to the extraordinarily high rate of conservation noted in this zone during the Early Classic period. Production failures were likely recycled into expedient or informal tool forms rather than discarded.

Aside from the possible Rio Hondo anomaly, the hypothesized relationship between relative local resource consumption and the presence of stone tool production evidence is quite well supported during the Early Classic period. Taken together with the evidence for a substantial increase in the proportional use of local lithic resources and high levels of resource waste, elites above the escarpment appear to have held great

control over resource use rights during this period. It is surely significant that 96.4% (N=798) of all flakes from an identified material source that were recovered in Early Classic elite contexts above the escarpment are from local lithic resources.

Table 36: Late Classic period consumption and production index comparisons among settlement precincts.

Settlement Zone	Location	Consumption Index	Production Index
Escarpment non-elite	above escarpment	73.1	7.7
Savannah non-elite	below escarpment	24.2	3.7
Savannah elite	below escarpment	33.2	4.8
Rio Hondo	below escarpment	71.1	0.0
Western Group	above escarpment	36.0	9.2
Site core	above escarpment	39.1	9.1

The hypothetical relationship between proportional resource use and evidence for stone tool production is not well supported by lithic data from Late Classic period deposits (Table 36). The major reason for this is the lack of direct production evidence from the Rio Hondo settlement zone.

However, data provided earlier in this chapter shows that the Rio Hondo precinct had the second highest proportion of flakes with greater than 25% cortex (although this is significantly less than is recorded in contexts above the escarpment during this period). Again, the lack of preforms and production failures in Rio Hondo deposits may be a reflection of the higher level of material conservation noted within this zone. Using cortical flakes as an ancillary measure of production, there is reason to believe that stone tool production occurred with some regularity in the Rio Hondo precinct.

The highest production index value is recorded from non-elite contexts above the escarpment, although this is only based on the analysis of 13 formal tools. Cortical

flakes are of little value in illuminating the proclivity for stone tool production in non-elite contexts above the escarpment because only 7 such flakes were recovered in these contexts. As non-elite settlements above the escarpment are closer to raw material outcrops than other settlement zones in the Blue Creek community are, a high level of local resource use and significant indices of production might be expected there.

Hypothesis Four

The fourth research hypothesis posits that localities that exhibited a higher proportional use of local raw materials and are characterized by lower levels of material conservation will display greater wealth. The logic driving this hypothesis is that the acquisition of critical economic commodities with no, or a very low, consequent investment of domestic resources frees convertible resources for alternative uses. Once freed for discretionary use, surplus resources can be invested in status accruing goods such as jade objects d'art or infrastructural endeavors such as architectural aggrandizement. Within this theoretical framework, the lack of direct lithic resource use-rights obligates individuals and groups to divest themselves of convertible claims in the acquisition of essential commodities, lowering their capacity for investing in discretionary, status-enhancing pursuits. This hypothesis is then intended to test the applicability of welfare economic theory (Sen 1981, 1992) in the context of studying ancient Maya political economies. Simply, if individuals or corporate groups enjoyed privileged access to lithic resources, and if these resources were indeed of strategic economic value, then greater entitlement to these resources will be associated with greater displays of economic capability such as more substantial architectural aggrandizement, a high relative frequency of exotic prestige goods, and burials that exhibit greater energy investment and more elaborate furnishings.

Wealth has been studied in archaeological contexts through various means. Recently, Guderjan and others (Guderjan, et al. 2003:19-20) contrasted elite and non-elite residences at Blue Creek based on spatial proximity to the central ceremonial precinct, viewshed, architectural form and complexity, and the possession of luxury

goods. This work relies on three criteria for assessing the relative economic capability of residential precincts at Blue Creek. It should be noted that there is a sizeable degree of variability for any of these indices within individual settlement precincts. However, sample size limitations would make a structure by structure analysis impractical. Therefore, wealth assessments represent the average expression for a given precinct. The one exception to this is the savannah settlement zone. Operations 1-3 at Sayap Ha and Structure U-5 at Chan Cahal likely represent elite administrative enclaves that were within decidedly non-elite settlement precincts, and certainly represent areas of greater resource mobilization capacity. Although these areas are elite in comparison to the remainder of their precincts, they are nonetheless decidedly sub-elite when compared architecturally to elite contexts above the escarpment. Regardless of any affiliation between those residing at these structures and the elites living above the escarpment in the site core and elite Western Group, these contexts present a clear departure in aggregate capabilities from the settlements surrounding them. I have analyzed them separately from other areas within their precincts, and designate them as *savannah elite* residences.

The first criterion I used to assess capability differences between settlement zones is architectural aggrandizement. The taxonomic nomenclature used in this study follows that commonly employed in the Maya lowlands (Ashmore 1981; Loten and Pendergast 1984). In rising order of complexity, structures are defined as isolated housemounds, housemounds within clusters, patio groups, courtyards, plazuelas, or plazas. Isolated housemounds are small, low structures that typically lack masonry walls. They have no overt affiliation with other structures. Housemounds within clusters are may be identical in form to isolated housemounds, but are located within larger settlement clusters. Clustered housemounds are afforded a greater hierarchical rank based on the likelihood of their being part of larger corporate entities (Lohse 2001). Patio groups typically consist of an unrestricted open area bounded by structures on two or three sides, creating an “L” or “U” shape plan. The architectural components making up a patio group may vary considerably in construction complexity, ranging from wattle

and daub to full masonry structures. Courtyards are comprised of several structures surrounding a relatively small bounded and highly restricted exterior space (Loten and Pendergast 1984:7). Courtyards are typically made up of buildings associated with a residential or administrative function. Plazuelas, defined by Thompson (1931), are similar to courtyards, but with a wider spacing of structures with less restricted access into interior spaces. Plazuelas may include ceremonial structures. Plazas are compositionally similar to plazuelas, but with larger structures and a more expansive interior space. Plazas almost invariably include ceremonial architecture. Excluding isolated housemounds, each of these architectural complexes manifests with a high degree of variability.

Table 37: Rank order of Blue Creek architectural complexes.

Architectural Form	Value
Isolated Housemound	1
Housemound within Cluster	2
Patio Group	3
Courtyard	4
Plazuela	5
Plaza	6

The implicit assumption in using architecture as a measure of wealth is that larger, more complex architecture represents a greater investment of resources, and by extension, a greater capacity to accumulate resources. Table 37 provides the value assigned to each class of architecture. I made no attempt here to determine the actual resource investment in various forms of architecture. Calculations of this nature are remarkably complex (Abrams 1994; Abrams 1998) and well beyond the scope of the current research. Thus, I compare architectural investment using the above ordinal scale which is a relative rather than an absolute measure of human and material resource investment. I made no assumption that plazas represent six times the labor investment of

isolated housemounds, only that housemounds represent the lowest architectural labor investment recognized in this work and that plazas represent the greatest.

The second criterion I used to assess capability differences between settlement zones is the volumetric distribution of jade artifacts. I measure jade by raw artifact count and do not take into account the volume of material excavated. I do not assume the distribution of jade to be entirely sensitive to the volume of excavated material because such artifacts are typically recovered from burial and cache deposits. As the number of burials and caches associated with a structure is often dependent on a structure's size, complexity, and longevity of occupation, there will be an inherent representational bias toward elite structures because a greater number of these features are typically encountered. This measure of wealth could be strengthened if some assessment of an artifact's relative value could be factored into it. There is tremendous variation observed in the nature of the various jade artifacts recovered at Blue Creek. While the characteristics of each artifact were not available for incorporation into this work, there is no straight forward means for assessing the relative value of individual artifacts. As value may have been figured by a number of means, including workmanship, size, means of acquisition, history of a piece, and its symbolic content, it is unlikely that an objective standard could be constructed and justified.

The final criterion I used to assess capability differences between settlement zones is burial elaboration. I identified graves as simple burials, chultuns, cists, crypts (graves), or tombs (chambers) (cf. Welsh 1988; Ruz Lhuillier 1965) and assigned an ordinal value based on the amount of energy invested in their construction (Table 38). These burial forms constitute a gross typology and an extraordinary range of variability can occur within any one type. While assigning ordinal values to interments based on the above typology is inherently subjective and does not attempt to account for the absolute labor investment represented by individual burials, this typology provides a useful baseline for qualitatively assessing the expenditure of resources devoted toward the dead for a given domestic unit. I also assess an average burial pattern by time period for each settlement precinct.

Table 38: Rank order of Blue Creek burial complexes.

Burial Type	Value
Simple Burial	1
Chultun	2
Cist	3
Crypt	4
Tomb	5

For the purposes of this study, I designate burials that are not associated with a discernable burial chamber as being simple burials. Such burials can commonly occur below house floors, in architectural construction fill, or in domestic middens. Importantly, they represent a minimum expenditure of energy. I also regard human remains contained within lip-to-lip vessel caches as simple burials in this work. In general, when burials of this type have been located at Blue Creek they tend to contain the remains of infants.

Chultuns are natural hollows in limestone bedrock. Such features are likely to have served a variety of functions (Ashmore 1981; Puleston 1971) and are only occasionally found to contain burials. Chultuns used as burial chambers are often culturally modified and are frequently sealed with capstones and fill (Ruz 1965).

Cists are defined as simple grave forms in which the individual is placed in a hollowed cavity or small pit; typically either in bedrock or sub-floor construction fills (cf. Loten and Pendergast 1984). Cists are typically shallow and spatially confined, and may be marked with a crudely constructed outline of stones or a capstone (Ruz 1965).

Following Ruz (1965:441) and Welsh (1988), crypts (Ruz uses the term “graves”) are defined as “types of coffins constructed of masonry or slabs, with a cover, with or without stucco floor, and large enough for at least one extended body.” The spatial dimensions of a crypt are usually slightly in excess of the area taken up by the human remains within them.

Tombs, the final burial type, are the most elaborate style of burial. Tombs are typically well-defined chambers with masonry walls, vaulted roofs, and an open air

space. Tombs vary in size, but generally create a space much larger than that required of the remains within them. Tombs may be specially constructed features or closed rooms within civic or ceremonial structures (Ruz 1965):441-442. These burial forms represent increased investments in labor, and together with the interment's furnishings, they provide some indication of the labor and material resource capabilities that could be mobilized by the different settlement precincts of the Blue Creek community.

None of the measures of economic capability outlined above function as an unequivocal index of resource mobilization potential when considered in isolation. However, when combined, patterns observed in each of these measures for the different settlement precincts should provide an accurate relative assessment of socio-economic stratification in the Blue Creek community.

Architectural values provided in Tables 39 - 42 represent the average rank for all structures within a settlement precinct that are represented within the lithic assemblage recovered from that precinct for a given time period. For example, I assigned all structures within the Rio Hondo settlement zone from which either flakes or formal tools were recovered in Early Classic period deposits an architectural value based on the ranking system provided in Table 37. The final architectural value provided is the average of individual structure values. Burial values are likewise averaged for settlement zones by time period.

Table 39: Comparison of all indices related to resource mobilization for settlement precincts during the Middle Preclassic period.

Settlement Zone	Consumption Index	Conservation Index	Average Architectural Rank	Jade Consumption (raw count)	Mortuary Investment	Relative Resource Mobilization Capability
Savannah non-elite	21.9	40.4	2	N = 0	NA	low
Site Core	28.9	39.8	2	N = 9	1 n = 1	low-moderate

The fourth hypothesis -that areas exhibiting greater proportional local resource consumption and proportionately less material conservation will display a greater capacity for mobilizing resources- is tentatively supported by data recovered from Middle Preclassic deposits (Table 39). However, sample size limitations call into doubt the accuracy with which these data reflect socio-economic relation within the Blue Creek community at this time.

Middle Preclassic deposits have been recovered from two deposits in the site core and three contexts in the savannah below the escarpment. The first site core deposit was from a cache dug into the bedrock underlying Plaza A (Thomas Guderjan, personal communication, 2003). This cache has no clear architectural affiliation. The second deposit was found in association with midden materials at the base of Structure 9 (Haines 1999). The first of the deposits below the escarpment was located in the Chan Cahal settlement precinct at Structure U-49. The second was located in the same precinct at Structure U-50. The final Middle Preclassic deposit found in the savannah zone below the escarpment was recovered in Operation 4 in the Sayap Ha settlement precinct.

Given the small number of Middle Preclassic contexts identified, it is unlikely that the available data represent an accurate characterization of the community. The limitations of the various means of addressing relative wealth are also clearly evident in reviewing the data in Table 39. First, architecture dating to the Middle Preclassic period is rarely found, making cross-community comparisons untenable. Second, the distribution of jade may depend less on the number of deposits found, and more on the nature of the deposits found. Middle Preclassic deposits below the escarpment were recovered from deeply buried midden deposits and sub-floor fill. Deposits of this nature rarely contain jade objects, and this observation is reinforced by the more abundantly investigated contexts of later time periods. In contrast, the Middle Preclassic cache deposits discovered in the site core did contain jadeite objects. Caches have proven extraordinarily productive for recovering jade at Blue Creek (e.g. Guderjan 1998, 2002). Thus, the disparity in jade dispersal observed between contexts located above and below

the escarpment in Middle Preclassic deposits may have more to do with the opportunistic discovery of ritual caches in the site core than with actual differences in economic capability between settlement zones.

The final obvious limitation of the attempt to address relative wealth in various settlement contexts concerns the practical and conceptual obstacles inherent in using burial data. The practical issues deal mainly with initially locating burials and subsequent preservation considerations. Locating burials is the greater issue of these as the preservation of human remains (which is invariably poor) is a minor consideration relative to determining the type of burial represented and nature of its furniture. Conceptual obstacles may be a far greater concern as they interject a degree of ambiguity into the valuation of any remains discovered. For example, in attempting to assess the relative amount of resources expended in the interment of individual one must assume that all human remains located represent the burials of individuals who lived in the architecture in which they were found. This may not in fact be the case. Interments may represent ritual sacrifices or other such cultural phenomena that bear no direct relationship to the burial of lineage members. One of the major obstacles this represents in is using the ritual offerings included within the burial as an ancillary means to assess economic capability. Sacrificial interments may not have warranted the inclusion of elaborate furniture or the divestment of wealth objects. Such interments, if not identified as such, would represent relatively poor burials and lower the overall assessment of resource mobilization capacity within the settlement zone of their occurrence. In many instances, a mortuary feature's relationship to the structure it is located in is opaque at best. However, there is much less ambiguity reflected in high status burials such as tombs. Such interments are clear markers of an enhanced capacity for resource investment.

Table 40: Comparison of all indices related to resource mobilization for settlement precincts during the Late Preclassic period.

Settlement Zone	Consumption Index	Conservation Index	Average Architectural Rank	Jade Consumption (raw count)	Average Mortuary Investment	Relative Resource Mobilization Capability
Savannah non-elite	23.4	36.4	2	N = 97	NA	moderate
Savannah elite*	NA	NA	4	N = 105	2 n = 3	high
Site Core	31.1	25.1	5	N = 17	1.4 n = 10	moderate

* Elite savannah deposit represents Tomb 5, a rich modified chultun burial located on a remnant limestone karst tower on the Rio Bravo flood plain.

Data recovered from Late Preclassic deposits do not support or reject the fourth research hypothesis (Table 40). I include elite savannah deposits here to offer a contrast in the distribution of jade during this period. However, there was no lithic data available from these deposits.

The most significant finding related to the distribution of wealth items during the Late Preclassic period at Blue Creek concerns the quantity of jade recovered between site core and savannah non-elite contexts. Considerably more jade was discovered in non-elite deposits below the escarpment, principally in excavations conducted at Structures U-49 and U-50 (Popson and Clagett 1999). Site core excavations produced a relatively minor number of imported jade objects. The disparity can likely be attributed to the differing nature of excavations in the two areas. Site core excavations of Late Preclassic architecture were primarily directed at exposure and documentation, and almost no intrusive excavations were performed (Guderjan, personal communication, 2004). In contrast, Chan Cahal excavations were much more invasive, with many deep and expansive penetrations (Popson and Clagett 1999). As a result, a higher number of caches were recovered in non-elite deposits below the escarpment.

As illustrated here, the variation in archaeological methodology can have a significant impact on attempts to objectively quantify differences in economic capability

between settlement contexts. The hypothesis would be better supported if architectural aggrandizement alone were used to assess differences in wealth.

Table 41: Comparison of all indices related to resource mobilization for settlement precincts during the Early Classic period.

Settlement Zone	Consumption Index	Conservation Index	Average Architectural Rank	Jade Consumption (raw count)	Average Mortuary Investment	Relative Resource Mobilization Capability
Escarpment non-elite	NA	NA	1.5	N = 1	NA	low
Savannah non-elite	21.8	23.0	2	N = 7	1.3 n = 3	low-moderate
Savannah elite	21.9	27.3	3	N = 0	NA	low-moderate
Rio Hondo	43.0	33.3	2	N = 0	NA	low
Western Group	NA	NA	3	N = 28	4.1 n = 4	high
Site Core	60.7	17.9	4.5	N = 1089	2.5 n = 4	very high

The hypothetical relationship between lithic resource consumption, waste, and economic capability is supported by data recovered from Early Classic period deposits, but some anomalies can be noted (Table 41). The anomalies are the result of high levels of local resource consumption in the Rio Hondo settlement precinct (discussed in the previous section) and relatively elaborate burials found in the elite residences of the Western Group above the escarpment. As there was not sufficient lithic data available from the elite Western Group deposits, however, they are not useful for addressing the relationship proposed in the research hypothesis.

The relatively high level of local resource use in the Rio Hondo precinct is likely due to the direct procurement of raw materials from the adjacent river channel. These resources were either not abundant enough or of too poor a quality to enhance the economic capacity of those in the Rio Hondo community. The relative poverty of this area can be observed in the high level of material conservation, the absence of jade at a

time when the Blue Creek community as a whole was realizing a period of relative opulence, and the decidedly inconsequential investment made in architectural construction in the zone.

Aside from these anomalies, the hypothesized relationship between lithic resource consumption, waste, and economic capability appears to be supported by the available data. The site core exhibits the highest relative consumption of local raw materials, the lowest level of material conservation, and the greatest amounts of wealth as determined by architectural aggrandizement, mortuary investment, and jadeite representation in the Early Classic period.

Table 42: Comparison of all indices related to resource mobilization for settlement precincts during the Late Classic period.

Settlement Zone	Consumption Index	Conservation Index	Average Architectural Rank	Jade Consumption (raw count)	Average Mortuary Investment	Relative Resource Mobilization Capability
Escarpment non-elite	73.1	16.7	1.5	N = 0	3.5 n = 2	low-moderate
Savannah non-elite	24.2	30.0	2	N = 0	1.7 n = 5	low
Savannah elite	33.2	34.7	3	N = 1	1.0 n = 5	low-moderate
Rio Hondo	71.1	29.2	2.5	N = 0	NA	low
Western Group	36.0	22.6	4.1	N = 3	2.1 n = 11	high-moderate
Site Core	39.1	27.9	4.7	N = 25	1.6 n = 7	high

Taken as a whole, data available from Late Classic period deposits do not support the research hypothesis (Table 42). Both the highest level of local material use and the lowest level of material conservation come from non-elite contexts located above the escarpment. This zone also exhibits a high mortuary score, but this derives from the excavation of only two burials (compared with 5 savannah non-elite, 5 savannah elite, 7 site core, and 11 elite Western Group burials). However, non-elite residences above the escarpment exhibit the least material and labor investment in

architectural construction. In general, non-elites residing above the escarpment appear relatively impoverished economically (inasmuch as they do not display a capacity for mobilizing wealth and status enhancing resources), yet they appear to have had fairly unrestricted access to utilitarian lithic resources available in their immediate landscape.

Elites residing above the escarpment exhibit marginally higher levels of local resource consumption and marginally lower levels of resource conservation than do contexts below the escarpment, yet they display a greater capacity for architectural aggrandizement and jade acquisition (though jade as a whole is very rare during the Late Classic period). Although elites residing above the escarpment do not appear to have held the same command over access to local lithic resources during the Late Classic period, they nonetheless continued to enjoy the trappings of a privileged class.

Evaluating the Theory That Lithic Raw Materials Were a Strategic Resource That Determined the Social Architecture of the Blue Creek Region

Evaluating the Strategic Value of Local Lithic Resources through Time at Blue Creek

The strategic value of a given resource is dependent upon the necessity of the resource, its substitutability, and the degree to which it can be alienated. The value of utilitarian lithic resources for the creation of tool forms is not questioned, particularly for the environmental region in which the site of Blue Creek is situated. The lack of viable substitutes is also evident. Finally, utilitarian lithic resources in the environs of Blue Creek are inherently alienable due to the patchy geological substrate of the Rio Bravo escarpment. As the technological basis of Maya subsistence economy and infrastructural engineering did not change in such a way as to relax the need for stone tools through time (at least through the Classic period), and as there was no change in the overall availability of raw material outcrops at Blue Creek, the measure most relevant to assessing the strategic worth of lithic resources through time is the degree to which it was alienated.

Alienation occurs when property ownership resides with some members of a society and not with others. Access to that property must be negotiated with its owners, and can be legitimately denied. The important components of resource alienation are

that there must be a mechanism for legitimizing alienation, a means to achieve alienation, and a dialogue between the endowed and the disenfranchised that allows for the negotiation of access privileges. I have proposed that the mechanism for legitimizing alienation was “first founder rights” (c.f. McAnany 1995), whereby those who first settled in the region, tied their lineage into the landscape, and claimed rights to productive resources. This may have been originally accomplished and institutionalized through time by settlement decisions. The means to achieve lithic resource alienation at Blue Creek was furnished through the natural distribution of outcrops. Finally, it is unlikely in an ethnically homogenous society that a critical resource could be completely alienated. In fact, Maya nobles are likely to have derived much of their authority through their ability to provision scarce resources through network relations. Furthermore, the strategic value of such resources depends on the ability to negotiate the terms of their access. Therefore, access privileges become an obligation of the endowed and a right of the disenfranchised, but those endowed with resource ownership are also entitled to seek compensation of granting this access.

At Blue Creek, I evaluated resource control through several means. First, I evaluated the percentage of the lithic artifact assemblage made up of local raw materials for each settlement precinct for each of the major lowland time periods. In general, this showed that, whether focusing on either count or weight, flakes are a more sensitive indicator of resource access than are formal tools. This is because there are several means by which a tool, once manufactured, may travel through a site, but flakes generally remain in the vicinity of their origin. Second, I compared the proportional amount of local materials within a given settlement zone to its proximity to lithic resource nodes. This showed that settlement precincts closer to raw material sources exhibited a far greater percentage of those resources in their flake assemblage, although there was only a marginally greater likelihood of local resources comprising a larger percentage of the formal tool assemblage. Third, I assessed the frequency of cortical flakes in the flake assemblages from each precinct. I regard a high percentage of cortical flakes in any settlement precinct as evidence for tool production, and hence, access to

lithic raw materials. The assessment of stone tool production activities was further gauged by observing the distribution of hammerstones and production failures. Finally, I assessed the level of material conservation in order to estimate the relative value placed on attaining and replacing resources. I did this under the assumption that, where resource use-rights were part of endowments, the cost of replacement was negligible, and this would be reflected in lower levels of resource conservation.

Middle Preclassic period deposits are underrepresented in the archaeological record at Blue Creek, as holds true for much of the Maya lowlands. The lithic data recovered in those deposits that have been located from this time period do show a statistically significant difference between contexts located above and below the escarpment. However, save for the recovery of a small quantity of jade in early site core deposits, Blue Creek appears to have been largely egalitarian at this time. It is questionable as to whether lithic resources were of any strategic value at this time.

While there is a statistically significant difference in the distribution of various raw materials (based on flake data), there is little in the way of supplementary evidence to suggest that lithic resources were of substantial economic value during the Late Preclassic period. While local resources are much more prolific in deposits above the escarpment, evidence of stone tool production is equally well represented in contexts located both above and below the escarpment. It is of course possible that a substantial amount of the production evidence observed among settlements in the savannah zone reflects the processing of resources that were procured in river channel deposits (as proposed for the Rio Hondo precinct during the Late Classic). However, the cortex characteristics observed on flakes within the Late Preclassic assemblage from below the escarpment suggests that materials were procured from a terrestrial source. Substantial quantities of jade were recovered from non-elite settlements below the escarpment from this time, suggesting that hinterland areas enjoyed a significant capacity for accruing wealth items. However, the amount of human and material resources invested into site core architecture at this time eclipsed any such endeavors from contexts below the escarpment by several orders of magnitude.

The picture that arises from Late Preclassic period data is that of a ceremonial elite with authority legitimized by heredity, but without any real coercive power. Elites may have controlled access to local lithic resources at this time, but they were unable to convert their endowments into exorbitant claims to human and material resources. The ready availability of resources from external resource zones may have ultimately served to constrain the reciprocal demands that those with endowed resource entitlements could place on those without them.

The strategic value of local lithic resource outcrops may have reached its apex during the Early Classic period. There is an unparalleled proliferation of local resources in the flake assemblage recovered in elite contexts above the escarpment, while the amount of resource conservation observed within those same contexts is among the lowest observed at the site at any point in time. The Early Classic period is a time of relative opulence at Blue Creek; elite architectural programs in the site core reached their zenith and there is an inexplicable proliferation of jade in site core deposits. Non-elite contexts in the savannah settlement zone exhibited remarkable access to jade during the Late Preclassic period, but these same contexts are nearly barren of the precious commodity in the Early Classic period. The declining capabilities of non-elite contexts below the escarpment becomes even more vivid when the enormous increase in jadeite witnessed within the site core is considered. The Early Classic period at Blue Creek appears to be characterized by increasing extravagance among the elite, and increasing disenfranchisement throughout the hinterlands.

Late Classic period data is in many ways a dynamic contrast to patterns of resource use observed during all earlier time periods at Blue Creek. When considered in its historical context, lithic data from Late Classic period contexts presents a clear picture of lithic resource alienation. Settlement at Blue Creek expanded exponentially after the seventh century, doubtlessly with a concomitant increase in the demand for stone tools. At the same time, there is evidence for increasing entropy in long-distance trade systems. The volume of goods entering Blue Creek from production NBCZ sites fell into a steep decline during the Late Classic. This created an inopportune decrease in

supply at a time when demand was at a maximum. As a result, regional resources from sites in the *bajo* region to the west and local resources were employed with much greater frequency. The tenuous situation caused by the sharp decrease in NBCZ imports also resulted in significantly higher rates of material conservation throughout the Blue Creek polity. The greater representation of local and regional resources in all settlement precincts during the Late Classic period attests to the greater reliance on these resources, and is not in and of itself evidence for an expansion of resource use-rights to all members of the community. In fact, evidence for stone tool production demonstrates that direct access to raw material outcrops remained strongly in elite control throughout the period. The lone caveat to this assessment is the Rio Hondo community, which is likely to have procured lithic resources directly from the adjacent river system.

Evaluating the Effects of Endowment and Entitlement Inequalities on the Disproportionate Distribution of Power, Prestige, and Wealth at Blue Creek

The preceding analysis of the Blue Creek lithic assemblage has shown that the site's elites maintained greater access to local utilitarian lithic resources for most of its occupational history. However, only during the Classic period were elites able to convert their resource monopolies into substantial gains in power, prestige, and wealth.

The earliest occupation at the site dates to the Middle Preclassic period, and most of the available evidence suggests that the community was not ranked, but was principally egalitarian at that time. Population levels were low, architecture was simple, and no readily apparent public works projects were undertaken. Weighing the evidence, resource needs must have been comparatively low. Lithic resource needs are likely to have increased substantially during the Late Preclassic period due to an exponential increase in population and architectural construction during this period, but there is surprisingly little to suggest that the community was marked by vast entitlement inequalities or that elites had access to coercive power. Instead, hinterland communities appear to have been capable of achieving both wealth items and critical economic commodities. The greatest disparity during this period appears to have been in the

ability to harness labor resources in the pursuit of architectural endeavors, but this does not necessarily dictate the presence of strong centralized political power (Hutson 2002).

The transition from the Preclassic into the Early Classic period was one of marked change in the underlying socio-economic (and possibly political) character of the site. Guderjan (1996:10) has stated that the royal lineage at Blue Creek was instated during the Late Preclassic period, and that the site was an independent polity by the Early Classic period. This is consistent with what other authors have noted in terms of general trends throughout the Maya lowlands:

Available evidence from the archaeological record suggests that the institution of *ahau* arose simultaneously throughout the Maya lowland region in the Late Preclassic period as an adaptive response to endemic and pervasive social conditions of de facto elitism and a period of some centuries of early centralization in some regions, such as Petén ... The institution of *ahau* constituted an overall reformulation of Maya culture that rendered elitism natural, rational, and necessary (Freidel 1992:128-129).

While the apparatus for legitimizing exploitative relationships seems to have crystallized during the Early Classic period in the form of divine kingship and rigidly defined social hierarchies, the organizational structure legitimizing these relationships was firmly in place from the earliest periods of occupation in the Blue Creek settlement zone. The mechanism that enabled the transformation in Maya leadership from its early basis in charismatic authority to its Classic period governmental form, predicated on coercive power, is one that has received only cursory attention among scholars. One of the major outcomes of this transformation appears to have been the institutionalization of the legitimization of inherited power. For example, Freidel and Schele state:

The transformation to the Early Classic is characterized by the adoption of firm genealogical principles of succession and firm ritual formulae, as carved on stone stelae, for achieving the status of *ahaw*. These products of the transformation suggest that the major problem with Late Preclassic kingship was the absence of a mechanism to ensure the stable transformation of central leadership over generations (Freidel and Schele 1988: 550).

Another change taking place in the political character of Maya society coincident with the transition into the Classic period was the proliferation of textual and

iconographic programs that visually reinforced the legitimacy of rulers (Freidel 1992; Freidel and Schele 1988). This materialization of ideology (DeMarrais, et al. 1996) supported the disparity growing in Early Classic Maya society between the entitlements of elites and non-elites. Demarest (1992:147) has suggested that religion constituted the main source of power for Maya rulers, and the pains taken by potentates during the Late Preclassic to tie their authority into cosmological principles of divine order are undeniable (Freidel 1992). However, the appropriation of religious ideology on the part of elites is more likely to have provided a method for legitimizing the growing inequalities in Maya society than it is to have precipitated them. The institution of cosmologically sanctioned kingship was so firmly entrenched in Maya society by the Early Classic period that the exploitive relationships propagated by inherent differences in resource entitlements, and the seemingly unrestricted power of Maya nobility derived from this basal inequality (which may have run counter to the largely egalitarian ethos of earlier periods (Freidel and Schele 1988), appeared both “natural, rational, and necessary” (Freidel 1992:128-129).

The influence of basal inequalities in resource access among the ancient Maya of Blue Creek can be expressed within a welfare economic model (Sen 1981, 1992). Where the economic needs of individuals and groups were not satisfied through their personal *endowments*, resources would have had to have been obtained through *exchange entitlements*. These are “the set of alternative commodity bundles that the person can command respectively for each endowment bundle” (Sen 1981:46). Capabilities would have been greater where *endowments* satisfied *needs*, leaving more *convertible resources* available for non-essential commodities, which are those items that may ultimately define economic stratification between individuals and groups. If all members of the Blue Creek community were to have had equal access to economically vital resources, these resources would have had no strategic value, and thus would have little influence on the bank of productive resources that groups were entitled to draw from through their *exchange entitlements*, which are the suite of goods those resources could be productively exchanged for (*capability sets*). However, where direct access to

such resources was not enjoyed equally by all members of the community, as I theorize here for the ancient Maya community at Blue Creek, obtaining these resources by means other than through *endowments* would decrease the value of *exchange entitlements* and reduce *capabilities*. Thus, the inclusion of direct lithic resource access within an individual's or corporate group's *endowment*, in conjunction with the legitimate right to alienate these resources from others, enriched the value of their *exchange entitlements*.

This basal inequality and the divergent capabilities produced through its disproportionate allowances became unchained from the egalitarian ethos of the Preclassic era, creating the vast differences in power, prestige and wealth that were observed during the Classic period. Economic inequality became increasingly manifest throughout the various settlement precincts at Blue Creek in higher levels of luxury goods, greater material and energy investment into architecture, and lower levels of resource conservation among elites residing above the escarpment.

CHAPTER VII

DISCUSSION AND CONCLUSIONS

The Organization of Resource Access at Blue Creek

The purpose of this work has been to test whether or not utilitarian lithic raw materials functioned as a strategic resource among the ancient Maya of Blue Creek, Belize. I regard resources as strategic when their access can be controlled by a limited number of individuals, thereby producing economic rewards for those managing use-rights. The most critical resources for any society are access to potable water and food. These resources constitute the core elements of an economy, and may lead to significant stratification within groups where inequality of access is maintained. A basic requirement for a resource to have functioned in this capacity is that it be alienable. Access to a resource may be limited if it is scarce, if access to the technology involved in its extraction is limited, if coercive force controls its restriction, or if social prohibitions differentially endow rights of access to individuals. With regard to incipient inequality in access rights to lithic raw material outcrops at Blue Creek, the first and last of these considerations are most important.

The physiography of the Maya lowlands is characterized by a mosaic distribution of economically important resources. Thus, regions and sub-regions often differ dramatically in the exploitive potential of various resources. At Blue Creek, utilitarian lithic raw materials are finitely distributed. In fact, productive outcrops are so limited that nearly half of all lithic resources consumed at the site during the Middle Preclassic period were imported from regional sources outside of the Blue Creek settlement zone. As Blue Creek was little more than a small nucleated village at the time, this level of overt economic dependency is striking. Utilitarian lithic outcrops in the Blue Creek settlement zone are restricted to the arroyos and diminutive *bajos* of the upper-escarpment plateau, and these are of moderate quality at best. Not surprisingly, settlements above the escarpment tend to be aggregated around these resources. The only source of utilitarian lithic resources below the escarpment is within the Rio Bravo

and Rio Hondo river channels. While raw materials were undoubtedly procured from these sources, harvesting such resources would have come with a greater expenditure of energy, and resource availability would likely have been less stable.

While the first criterion of resource alienation -a scarce and limited distribution- appears to be in place at Blue Creek, this would only have allowed lithic resources to have held an economically strategic position if social mechanisms allowed some individuals to prevent others from directly accessing raw material outcrops. In many pre-state societies, social norms act to preserve an egalitarian ethos within a community. Greater concentration of wealth by select individuals is viewed unfavorably as anti-social behavior. One of the major transformations in society that eventually led to the more complex and exploitative infrastructure of the state was the replacement of these institutionalized leveling mechanisms. In their wake, political economies developed that channeled greater human and material resources to some individuals and groups while disenfranchising others.

This work has been principally concerned with the primary legitimizing mechanisms that culminated in institutionalized inequality. The most logical mechanism allowing inequality in resource access -which effectively justified the relative deprivation of critical resources within the community- is the principle of first occupancy. The first occupants of the Blue Creek community would have held primary claims to the most productive resources. As the site prospered and grew, other groups would have been attracted to the area. However, these groups would not have had the same resource endowments as did the first founders. It is not likely a coincidence that the two settlement precincts that exhibit the oldest evidence of settlement, the site core and Chan Cahal, each show the greatest levels of absolute local resource access through time. Even though Chan Cahal is located below the escarpment, it seems that some members of this settlement precinct retained full resource access based on first founder endowments. However, residents of the site core seem to have had a greater ability to exploit the resource for economic gain. Thus, proximity to the resource seems to have had an important influence on its utility as a finance mechanism.

Several financial mechanisms have been proposed for the ancient Maya, and many are likely to have been important to the development and maintenance of institutionalized inequality. Some, such as intensified domestic production, are unlikely to have produced the enduring mechanisms of an institutionalized political economy because they lack generational stability. Others, such as hydraulic management and elite redistribution, presuppose a primary level of social stratification that fails to account for the mechanisms that legitimize basal inequality in entitlements and capabilities. Financial systems based on staple finance, tribute mobilization, and assigned production can only develop where a mechanism that legitimizes disproportionate rights to access and exploits economically critical resources is in place. Legitimized by first founder endowments, strategic resource control provides such a legitimizing mechanism.

Inequality Institutionalized

The unequal distribution of lithic resource use-rights would have obligated a resource expenditure on the part of the disenfranchised that would have lowered the value of their exchange entitlements while augmenting the exchange entitlements of those in a position to grant resource access. Over time, this relationship would have manifest in substantial differences in achievements between individual and groups, such as is observed in architectural aggrandizement and consumption of prestige goods like jade and *Spondylus* shell. Whether or not Maya society was organized around a rigid class system remains a contentious issue. Still, the divergent achievements exhibited by groups within the community are more likely to have been produced by differences in economic capability than by absolute differences in substantive freedoms. The absence of jade in non-elite contexts, for example, is better explained by real differences in the value of discretionary convertible claims than it is the enactment of a sumptuary law that prevented non-elites from accessing prestige items.

The Enforcement of resource alienation is an important feature of political economies in all stages of their development. Coercive force may have been employed to restrict access to strategic resources at the largest of Maya polities, such as at Tikal,

but there is no evidence to support the presence of such mechanisms at Blue Creek. Rather, I suggest that access restrictions were enforced by relying on realized property rights and the moral obligations of community kin-based reciprocal relationships. The ethic-based structure of such relationships would not have allowed absolute alienation from critical resources, but rather would have mitigated relative deprivation while providing a financial apparatus for incremental inequality.

With respect to the kinship and stratified models proposed by Webster (2000), I would suggest that Blue Creek, like Copan, better exemplifies a polity that was internally organized around the kinship ethic. However, I disagree with his argument that commoners were naturally granted resource use-rights sanctioned through this ethic. Rather, I suggest that commoners could not be denied the right to attain resources provided that the value of their exchange entitlements was sufficient enough to command such a transaction. The difference here is more than semantic. In the first instance, the legitimacy of the transaction is wholly bound within the context of kinship relations, while the importance of kinship is secondary to economic capabilities in the second. Further, I do not believe that emergent differences in power, prestige and wealth were necessarily based directly on the position individuals held in descent groups. Rather, I believe that the divergent capabilities of individuals and groups were principally based on the innate value of their endowments as structured through the principles of first occupancy.

The stratified model proposed by Webster (2000) states that elites effectively owned and managed all productive resources and that commoners were granted resource use-rights in exchange for claims to their surplus production or labor. This may have essentially been true, but with one important caveat. Elites are likely to have become elites because they effectively owned and managed strategic resources, rather than the other way around. Coercive power was not a precondition for marginalizing commoners and alienating them from the means of production. Rather, first occupancy principles established basal inequities in resource access that over time allowed some members of the community to accrue the necessary means to exercise coercive power and to

accelerate the political marginalization of others. Over time, these relationships became bound and codified within a legitimizing ideology that made the growing disparities in realized levels of power, prestige and wealth appear natural and even desirable.

The Nature and Degree of Hinterland Autonomy through Time at Blue Creek

As Scott (1976) has pointed out that the human and material resources demanded in exchange for access to critical resources, and the disparities in economic capabilities realized through these relationships, need not have been considered exploitative by non-elites. So long as the basis for socio-economic inequality was predicated on legitimate, culturally-accepted norms of property ownership, and so long as all members of the community retained the ability to meet their minimal domestic resource needs, the demands associated with resource access were likely to have been considered fair and justified. This is not to say that groups did not seek to better their socio-economic standing, nor does it imply that the disenfranchised passively accepted their dependency on the emergent (and later established) elite class.

Those endowed with unrestricted access to scarce, critical resources received great financial benefits from these endowments. However, if this was their right, substantial obligations would have also been realized. Such individuals and groups effectively served as resource managers, and would have been responsible for ensuring others in the community were adequately provisioned. This is the basis of the kinship ethic as discussed by Webster (2000). Thus, elites (emergent or established) would have played an important role in the domestic economy of their hinterlands. The domestic importance of elites in hinterland areas where critical resources were largely available and inalienable would have been substantially less. At Blue Creek, many hinterland areas are impoverished with regard to utilitarian lithic resources, and the residents of such precincts are likely to have depended substantially on resources that were controlled by elites. The level of integration realized within Maya polities and the amount of power enjoyed by the political elite were both likely influenced to a large

extent by the capacity for resource alienation and control. In turn, this was predicated on the underlying structure of resource distributions across lowland landscapes.

The centripetal tendency for Maya commoners to aggregate around urban centers was accomplished through perceptions of self-interest rather than coercive force. However, as a group's investment into community relations and subsistence infrastructure increased over time, their ties to an area would have become increasingly difficult to sever. Such investments would have been the prime mechanism leading to the "caging" of Maya populations, as was undoubtedly the case at Blue Creek (after Mann 1986). Neither coercive force nor environmental circumscription appears to have provided a viable caging mechanism within the Maya lowlands. As stated previously, groups would have actively sought to better their socio-economic positions, however possible, rather than passively accept an ever increasing dependence on elites.

Subaltern strategies for resisting elite hegemony and preserving hinterland autonomy are likely to have been subtle actions that did not directly seek to disrupt the social harmony of a polity. This would have been particularly true where the finance mechanisms of the emergent elite were based on legitimate manipulation of resource endowments rather than the exercise of coercive force. At Blue Creek, the preference observed in hinterland communities for the consumption of exotic cherts that were supplied through long-distance trade may have been a purposeful strategy intended to limit dependence on local elites. Similarly, choosing to invest greater energy in procuring lithic raw materials from riverine sources would have provided an attractive alternative to those not wishing to channel more human and material resources to elites. Either strategy would decrease dependence on local elites without challenging the legitimacy of entitlement inequalities.

The Complexity of Economic Decision Making

A resistance to increased stratification provides only one possible explanation for consumption patterns observed within the Blue Creek community. There are many other

factors that could have influenced consumer procurement decisions, and several present much more salient considerations.

One of the most influential factors influencing consumer choice was undoubtedly material quality. Lithic raw materials that outcrop in the Blue Creek settlement zone can be largely characterized as coarse-grained cherts, sedimentary quartzites, and dolomites. While these materials offer some utility for the construction of stone tools, they are of decidedly lower quality than the chalcedonies that outcrop in the *bajo* region west of Blue Creek, and they are of much lower quality than the fine-grained cherts that come from the northern Belize chert zone quarries. I base my assessment of quality on how much energy is expended in treating the raw material to make it amenable to flaking, the overall durability of the material, and the extent to which the material may be recycled. Few if any of the lithic raw materials available at Blue Creek can be manufactured into tool forms without thermal alteration. The coarse-grained nature of most local materials produces a non-durable edge, which likely explains the number of ground- and polished-bit tool forms. Finally, the coarse-grained structure of many local materials makes the production of sharp, acute edges difficult to fabricate, and significantly limits recycling. Many tool forms constructed out of local quartzites and dolomites are discarded while a sizable mass of material remains.

In contrast, cherts from the northern Belize chert-bearing zone require no thermal alteration, produce sharp, durable edges, and may be extensively recycled. In fact, it is difficult to determine the exact corpus of stone tools imported to Blue Creek from Colha workshops based on the excessive recycling of northern Belize cherts. Colha formal tools are largely only identifiable at Blue Creek from their occasional appearance in cache deposits in elite contexts. When the extensive recycling of Colha tool forms is considered in conjunction with the generally greater levels of material curation in hinterland contexts at Blue Creek, it seems plausible that NBCZ cherts represented a more practical resource investment for hinterland non-elites. However, such a decision would have likely weighed the cost of local or regional alternatives and factored in both

absolute necessity and availability. Thus, hinterland consumption decisions were dynamic processes that balanced the desire for autonomy, utility, and overall efficiency.

Elite commodity consumption was no less complex. While elites residing above the escarpment enjoyed unrestricted access to local resources, such resources were not well suited to all tasks. Furthermore, exotic commodities, particularly those with non-utilitarian functions, would have been desirable as conspicuous displays of elite capability. However, those endowed with direct access to locally available lithic raw materials would have utilized such resources preferentially because doing so would not have lessened their exchange entitlements, but would have left them more available resources with which to appropriate non-essential commodities and labor, each of which contributed to the material affirmation of their privileged status. Elite contexts at Blue Creek do in fact exhibit greater proportional use of local raw materials, even though such materials are of poorer quality than available imports. This presents an interesting counter position to the view that exotic commodities represent prestige items by their nature. It would seem instead that exotic commodities represent prestige items when they carry a symbolic message (as is the case with eccentric forms), or when their distribution is restricted (as with exotic fine-grained brown cherts in Late Classic period contexts at Blue Creek). Regardless of their loci of manufacture, utilitarian tool forms do not appear to have held particular prestige. There is a tendency for formal tools of exotic origin, in both utilitarian and more overtly ceremonial forms, to be located within elite cache deposits. Based on this trend, it is plausible that utilitarian commodities could have achieved prestige status through the context of their use and deposition.

The Economic Role, Nature, and Extent of External Economic Relationships

There is some question as to whether import commodities arrived at Blue Creek through the efforts of local elites or by independent entrepreneurial interests. The reality is that both are likely to have played an important role in the flow of external resources into and through the Blue Creek community. Local elites are likely to have buttressed the legitimacy of their elevated social position by establishing and maintaining social,

economic, and political ties with other regions. However, it is equally likely that specialized production sites, such as Colha, actively sought client sites through economic self-interest. Elite exchange may have been little more than an aesthetic overlay that lent official sanction and ceremony to otherwise autonomous, market-oriented transactions (cf. Malinowski 1920).

The only lithic evidence for elite redistribution comes from the distribution of FGB chert tools during the Late Classic period. These tools emanate from an unidentified, exotic resource zone and are found only in Late Classic period deposits. The tool types made of this chert are restricted to laurel leaf bifaces, stemmed bifacial points, and eccentrics (Appendix A). The quality of FGB chert is among the finest in the Maya lowlands, and it is hard to imagine that it would not have been desirable to utilitarian consumers. Laurel leaf bifaces would have been particularly well suited for domestic tasks. However, FGB tool forms are located almost entirely in elite contexts, which suggests that this resource was not available through standard market channels.

The acquisition of imported stone tools must have been accomplished through the exchange of equivalencies. There is no firm evidence to determine the exact nature of these equivalencies, but it is reasonable to suggest that they included agricultural products from Blue Creek's extensive network of channelized fields, as well as upland forest products such as mahogany, copal, and animal products. Based on the position of Blue Creek in the long-distance trade network, it is similarly reasonable to suggest that the acquisition of imported tool forms from regional sources was accomplished through the exchange of exotic commodities brought to Blue Creek through the trade system.

The Organization of Lithic Production

Stone tool production was concentrated in elite contexts beginning in the Early Classic period, and reached the height of its consolidation during the Late Classic period. This corresponds to increasing socio-economic stratification throughout the community and suggests that utilitarian lithic raw materials were indeed a strategic resource.

With regard to independent and attached specialization in the production of stone tools, both organizational systems may be observed at Blue Creek. The Preclassic period appears to have been largely characterized by individual specialization and dispersed workshops. Beginning in the Early Classic period, this organizational system begins to yield to individual retainer or nucleated corvee workshops (after Costin 1991), with production centered within elite precincts. Outlying settlement zones such as the Rio Hondo precinct appear to have maintained a level of self-sufficiency based on exploiting procurement alternatives. Indeed, lithic data suggests that the Rio Hondo community relied on individual specialization in stone tool production throughout the Classic period. The proliferation of informal tool types within this settlement zone likely reflects this trend as much as it reflects the community-wide specialization in craft production that apparently took place within that zone.

Contribution of This Study to Long-term Goals of Research at Blue Creek

This study addresses three of the long-term research goals discussed by Guderjan (1996) with regard to archaeological investigations at Blue Creek. These are 1) testing whether Blue Creek was a “daughter site” of a larger political entity, 2) examining the apparent interactive dynamics between the Petén and northwestern Belize, and 3) assessing Blue Creek’s possible “function” with regard to inter-polity trade.

The high level of prestige good consumption at Blue Creek suggests that the site was autonomous, at least through the mid sixth century AD. Although the site was always dependent on external sources of lithic raw material, this economic dependency seems not to have been associated with any overt form of political dependence. However, in the absence of hieroglyphic texts, there are few means available at the site to explicitly test the nature of political relationships. There is some suggestion that Blue Creek may have fallen under the hegemonic influence of a larger regional entity such as La Milpa during the Late Classic, based on a dramatic decline in the amount of exotic commodities found at Blue Creek during that period. However, this is as likely to have been caused by increasing entropy in the infrastructural support for long distance

exchange as it is a reflection of local political fluctuations. Increased regionalism is a hallmark of the late eighth and ninth centuries throughout much of the lowlands.

The interactive dynamics between the Petén and northwestern Belize can be observed through study of the patterns of stone tool manufacture and tool use in each region. From a lithics standpoint, the technological system employed in the manufacture of stone tools at Blue Creek is directly derived from production technologies found in the central lowlands, and stands in sharp contrast to production technologies employed throughout northern Belize. Stone tool manufacture in northern Belize workshops is dominated by a technology centered on the reduction of macro-flake and macro-blade blanks. This technology is not observed at Blue Creek, nor is it found in the Petén. Rather, production technology in these areas is centered on bifacial reduction of tabular nodules. Based on this observation alone, northern Belize appears to hold a much stronger cultural affiliation with the Petén than it does with northern Belize. It would be reasonable to suggest that Blue Creek's affiliation with sites in the central lowlands was predicated on kinship ties and alliances, while its affiliation with coastal and northern Belize was more expressly economic.

Blue Creek's heavy reliance on utilitarian lithic products produced in northern Belize workshops presents a challenge to distance decay models that have been proposed to explain the distribution of commodities along long distance trade networks (Santone 1997). Blue Creek's ability to draw resources in substantial quantity from distant source zones underscores its integration and overall importance in the circum-Caribbean exchange network. Located at the furthest navigable point along the Rio Hondo, the site was almost certainly an important transshipment port. Once exotic commodities arrived at Blue Creek they would have been transported via overland trade routes to inland consumption areas. While it is difficult to show that jade artifacts or Colha macroblades recovered at the sites of La Milpa or Rio Azul arrived there by way of Blue Creek, it is difficult to deny that this would have been the most efficient means for their introduction. In addition, Blue Creek would have been a logical port through which upland commodities such as mahogany, cacao, copal, jaguar pelts, and exotic feathers

entered the coastal trade network and distant markets. In summary, along with the site's geographic position at the headwaters of the Rio Hondo, the volume of exotic commodities recovered in excavations at Blue Creek support the argument that the site functioned as a commercial conduit linking divergent resource zones (cf. Guderjan 1996).

Contribution of This Work to Maya Archaeology

Three basic themes permeate this study. The first theme explores the potential of lithic research to contribute to the study of dynamic cultural processes in complex society. Utilitarian lithic raw materials were shown to have been critical to the Maya lifeway because stone was the central material on which their subsistence technology was based. If stone were not as necessary to the perpetuation of human life as was potable water, it was every bit as necessary to the preservation of the Maya lifeway as agricultural land, maize or cotton. Its fundamental importance is further underscored by the ubiquity of stone tools, formal and informal, in Maya settlement contexts. The lack of locally available utilitarian lithic resources at Blue Creek seems only to have altered patterns of recycling and rejuvenation, but the absolute need for stone remained.

Blue Creek's economic needs could not have been supported strictly through exploiting local lithic resources because those available were not present in sufficient quantity. Thus, imported tool forms account for more than half of those recovered through most of the site's occupation history. Examining the patterns of import distribution and consumption has provided important information regarding the ability of local elites to monopolize the provisioning infrastructure for critical subsistence commodities. Importantly, the role of external supply nodes as a critical component of this provisioning infrastructure is illustrated. This contributes valuable insight into the role of interregional trade and markets in fostering or hindering the development of complex political economies.

Based on the patterns of stone tool production, distribution, and consumption at Blue Creek, it appears doubtful that local elites were able to restrict access to commodities that entered the community through long distance networks. This may not

have been the case at all Maya sites, and the extent to which this relationship may be observed elsewhere needs to be more broadly researched in other lowland Maya contexts. Lithic research at Blue Creek has proven successful in directly addressing the institutional basis for emergent and entrenched inequality, and it has provided valuable insight on the processes and mechanisms that both retarded and motivated socio-economic stratification. While many researchers have addressed the political economies of the Maya lowlands, few have incorporated non-obsidian lithic data to any substantial degree.

The second theme involves testing the utility of welfare economic theory within an archaeological context to elucidate the infrastructural mechanisms that produce inequality in economic capability between groups within Maya communities. The application of any economic model depends on the visibility and transparency of economic indicators, which can present a challenge for archaeologically-derived data. Based on the economic importance of lithic resources and their high level of visibility in the archaeological record, stone tools and production waste provide an ideal medium for studying important aspects of the ancient Maya economy. Unlike theories of social evolution that rely on abstract paradigms developed out of comparative ethnography or Colonial period ethnohistory, lithic analysis -particularly in areas of scarce availability- provides a direct, observable means for studying the development and maintenance of political economies in the Maya lowlands.

Using lithic artifacts as an economic marker, welfare economic theory has provided a conceptual structure for observing relationships that directed the flow of human and material resources throughout the Blue Creek community. In so doing, the inception and development of economic inequalities can be explained. Initial disparities in use-right arrangements produce substantial, accumulative inequality in economic capability and achievements. Most studies of Maya political economy focus on the machinations of entrenched power structures. Using welfare economic theory, this study has been successful in examining the basal relationships that may ultimately lead to these power structures.

The final theme of this work involves employing a landscape archaeological approach toward studying patterns of resource procurement, processing, distribution, and consumption at Blue Creek (after Fisher and Thurston, 1999). This approach inhibits a static view of human and environmental influences on a landscape, instead realizing the dynamic flexibility that may be exhibited in each. The landscape archaeological approach focuses on the existence of a dynamic, accumulative, humanly built and maintained environment where humans groups continuously alter, and are altered by, their ecological setting. The landscape approach also stresses that landscapes are the products of historical processes in which natural and anthropogenic processes bring about transformations in landscape structure. At Blue Creek, the demand for lithic raw materials increased exponentially as the site grew in size. Not only was there a greater number of consumers, but the scale of infrastructural improvement projects also increased. Natural processes also altered the demand for lithic resources. The water table below the escarpment rose at some time during the Classic period and required the excavation of extensive drainage canals. Check dams and terraces were also constructed in upland areas to avert the erosion of soils. Such innovations would have undoubtedly changed the structure of demand for stone tools.

Finally, landscape archaeology stresses the continuous exchange of influences taking place between humans and the natural environment. Neither natural nor anthropogenic inputs into the system necessarily take precedence in the metamorphic processes that affected realized landscapes. The ancient Maya of Blue Creek undoubtedly viewed their site as an important link between the central lowlands and rest of the Maya world. Located at the edge of the Rio Bravo escarpment, Blue Creek represented an eastern enclave of central lowland culture. Its position at the headwaters of the Rio Hondo made the site an important node for communication and commercial interaction. While the site realized serious natural resource limitations, the detrimental effects of critical resource scarcity were countered by the constant flow of import commodities.

I conclude that dialectical influences of natural scarcity and external supply appear to have been the central factors determining the socio-economic architecture of the Blue Creek community. A political economy developed around the control of strategic economic resources, which included utilitarian lithic raw materials and presumably other resources. The oldest settlement areas were endowed with inalienable use-rights that were predicated on the principle of first occupancy, and this basal imbalance in resource access developed over time into manifest inequality in economic capability and realized achievements. Blue Creek maintained a significant reliance on imported stone tools throughout its history, although the level of dependence placed on particular external source zones changed through time. Proportionally fewer tools were imported from northern Belize workshops during the Late Classic period when long-distance trade became increasingly unstable. At the same time much of northwestern Belize -including Blue Creek- experienced a growing sense of regionalism. Coincident with this escalating regionalism, significantly higher levels of material recycling are observed at Blue Creek, which suggests that there was less overall certainty in the mechanisms of external supply.

Thus, non-obsidian lithic analysis has provided a vivid depiction of spatial and temporal adaptation and change over time, as well as periodic disturbances in the long-term equilibrium within the Blue Creek community. Lithic artifacts are among the most enduring material remains found at Maya sites, yet they have been overlooked in most all archaeological work carried out in the lowlands. Only through the systematic incorporation of non-obsidian lithic analysis, including the rigorous assessment raw material availability, will a dataset capable of addressing questions relating to the dynamics of ancient Maya economic organization be developed.

REFERENCES CITED

Abrams, E. M.

1994 *How the Maya Built Their World: Energetics and Ancient Architecture*. 1st ed. University of Texas Press, Austin.

1998 Structures as Sites: The Construction Process and Maya Architecture. In *Function and Meaning in Classic Maya Architecture*, edited by S. D. Houston, pp. 123 - 140. Dumbarton Oaks, Washington, DC.

Adams, R. E. W. (editor)

1984 *Rio Azul Project Reports, Number 1: Final 1983 Report*. Center for Archaeological Research, The University of Texas at San Antonio, San Antonio.

Adams, R. E. W.

1970 Suggested Classic Period Occupational Specialization in the Southern Maya Lowlands. In *Monographs and Papers in Maya Archaeology*, edited by W. R. Bullard, Jr., pp. 487-497. Papers of the Peabody Museum of Archaeology and Ethnohistory, Vol. 61. Harvard University, Cambridge, MA.

1973 The Collapse of Maya Civilization: A Review of Previous Theories. In *The Classic Maya Collapse*, edited by T. P. Culbert, pp. 21-34. University of New Mexico Press, Albuquerque.

Adams, R. M.

1976 The Emerging Place of Trade in Civilizational Studies. In *Ancient Civilization and Trade*, edited by J. A. Sabloff and C. C. Lamberg-Karlovsky, pp. 451-464. University of New Mexico Press, Albuquerque.

Ahler, S. A.

1988 Mass Analysis of Flaking Debris: Studying the Forest Rather than the Tree. In *Alternative Approaches to Lithic Analysis*, edited by D. O. Henry and G. H. Odell, pp. 85-118. Archaeological Papers, Vol. 1. American Anthropological Association, Washington, DC.

1989 Experimental Knapping with KRF and Midcontinent Cherts: Overview and Applications. In *Experiments in Lithic Technology*, edited by D. S. Amick and R. P. Mauldin, pp. 199-234. Vol. 528. British Archaeological Reports International Series 528. Oxford.

Aimers, J. J., T. G. Powis and J. J. Awe

2000 Preclassic Round Structures of the Upper Belize River Valley. *Latin American Antiquity* 11(1):71-86.

- Aldenderfer, M., L. R. Kimball and A. Sievert
 1989 Microwear Analysis in the Maya Lowlands: The Use of Functional Data in a Complex-Society Setting. *Journal of Field Archaeology* 16(1):47-60.
- Andrefsky, W.
 1998 *Lithics: Macroscopic Approaches to Analysis*. Cambridge Manuals in Archeology. Cambridge University Press, Cambridge, England.
- Andrews, A. P.
 1980 *Salt-making, Merchants and Markets: The Role of a Critical Resource in the Development of Maya Civilization*. University of Arizona Press, Tucson.
 1990 The Role of Trading Ports in Maya Civilization. In *Vision and Revision in Maya Studies*, edited by F. S. Clancy and P. D. Harrison, pp. 159-168. University of New Mexico Press, Albuquerque.
- Andrews, A. P. and S. B. Mock
 2002 New Perspectives on the Ancient Maya Salt Trade. In *Ancient Maya Political Economies*, edited by M. A. Masson and D. A. Freidel, pp. 307-334. AltaMira Press, New York.
- Andrews, E. W.
 1969 *The Archaeological Use and Distribution of Mollusca in the Maya Lowlands*. Middle American Research Institute, Tulane University, New Orleans.
- Andrews IV, E. W. and I. Rovner
 1975 Archaeological Evidence on Social Stratification and Commerce in the Northern Maya Lowlands: Two Masons' Tool Kits from Muna and Dzibilchaltun, Yucatan. In *Archaeological Investigations on the Yucatan Peninsula*, edited by M. A. L. Harrison and R. Wauchope, pp. 81-100. Publication 31. Middle American Research Institute, Tulane University, New Orleans.
- Andrews, G. F. and D. L. Hardesty
 1989 *Comalcalco, Tabasco, Mexico: Maya Art and Architecture*. 2nd ed. Labyrinthos, Culver City, CA.
- Anovitz, L. M., J. M. Elam, L. R. Riciputi, and D. R. Cole
 1999 The Failure of Obsidian Hydration Dating: Sources, Implications, and New Directions. *Journal of Archaeological Science* 26(3):297-302.
- Aoyama, K.
 1999 *Ancient Maya State, Urbanism, Exchange, and Craft Specialization: Chipped Stone Evidence from the Copán Valley and the La Entrada Region, Honduras*. University of Pittsburgh Memoirs in Latin American Archaeology, No. 12. University of Pittsburgh Dept. of Anthropology, Pittsburgh, PA.

Ashmore, W.

- 1981 Some Issues of Method and Theory in Lowland Maya Settlement Archaeology. In *Lowland Maya Settlement Patterns*, edited by W. Ashmore, pp. 37-69. School of American Research Advanced Seminar Series. University of New Mexico Press, Albuquerque.

Ashmore, W. and A. B. Knapp

- 1999 *Archaeologies of Landscape: Contemporary Perspectives*. Blackwell Publishers, Malden, MA.

Baker, J.

- 1997 Investigations in the Ditched Agricultural Fields. In *The Blue Creek Project: Working Papers from the 1996 Field Season*, edited by W. D. Driver, H. L. Claggett, and H. R. Haines, pp. 71-78. Maya Research Program, San Antonio, TX.

Ball, J. W.

- 1993 Pottery, Potters, Places, and Polities: Some Socioeconomic and Political Implications of Late Classic Maya Ceramic Industries. In *Lowland Maya Civilization in the Eighth Century A.D.*, edited by J. A. Sabloff and J. S. Henderson, pp. 243-272. Dumbarton Oaks, Washington, DC.

Bamforth, D. B.

- 1986 Technological Efficiency and Tool Curation. *American Antiquity* 51(1):38-50.

Barnhart, E. L.

- 2001 *The Palenque Mapping Project: Settlement and Urbanism at an Ancient Maya City*. Unpublished Ph.D. dissertation, Department of Anthropology, The University of Texas at Austin.

Barrett, J. W.

- 1999 *The Interpretation of Postclassic Lithic Production Patterns at Colha, Belize through a Synthetic Analysis of Archaeological Data*. Unpublished M.A. thesis, Department of Anthropology, Texas A&M University, College Station.
- 2000a Excavations at Structure 5: Postclassic Elite Architecture at Caye Coco. In *Belize Postclassic Project 1999: Investigations at Progreso Lagoon*, edited by M. A. Masson and R. Rosenswig, pp. 31-58. Institute of Mesoamerican Studies Occasional Publication, The University at Albany, State University of New York.
- 2000b *Warfare or Welfare: Postclassic Stone Tool Production and Its Social Context*. Paper presented at the 65th Annual Meeting of the Society for American Archaeology, Philadelphia, PA.

- 2001 *Site-level Economics in the Maya Lowlands: Lithic Resource Investigations at Blue Creek, Northwestern Belize*. Paper presented at the 66th Annual Meeting of the Society for American Archaeology, New Orleans, LA.
- 2003 *Constructing Hierarchy through Entitlement*. Paper presented at the 67th Annual Meeting of the Society for American Archaeology, Milwaukee, WI.
- Barrett, J. W. and T. H. Guderjan
- 2004 A River Docking Feature at Blue Creek. Manuscript on file, Department of Anthropology, Texas A&M University, College Station.
- Barrett, J. W. and A. K. Scherer
- 2002 *Stones, Bones, and Crowded Plazas: Evidence for Terminal Classic Maya Warfare at Colha, Belize*. Paper presented at the 67th Annual Meeting of the Society for American Archaeology, Denver, CO.
- Bauer, J.
- 1974 *A Field Guide in Color to Minerals, Rocks, and Precious Stones*. Chartwell Books, Inc., Secaucus, NJ.
- Baumler, M. F. and C. E. Downum
- 1987 Between Micro and Macro: A Study in the Interpretation of Small-sized Lithic Debitage. In *Experiments in Lithic Technology*, edited by D. S. Amick and R. P. Mauldin, pp. 101-116. British Archaeological Reports International Series 528. Oxford.
- Beach, T.
- 1998 Soil Catenas, Tropical Deforestation, and Ancient and Contemporary Soil Erosion in the Petén, Guatemala. *Physical Geography* 19(5):378-405.
- Beach, T. and N. Dunning
- 1997 An Ancient Maya Reservoir and Dam at Tamarindito, El Petén, Guatemala. *Latin American Antiquity* 8(1):20-29.
- Beach, T. and S. Luzzadder-Beach
- 2004 Geoarchaeological Investigations at Blue Creek, 2003. In *2003 Season Summaries of the Blue Creek Regional Political Ecology Project, Upper Northwestern Belize*, edited by J. C. Lohse. Report submitted to the Institute of Archaeology, Belmopan, Belize.
- Becker, M. J.
- 1973 Archaeological Evidence for Occupational Specialization among the Classic Period Maya at Tikál, Guatemala. *American Antiquity* 38(4):396-406.

- 1983 Indications of Social Class Differences Based on the Archaeological Evidence for Occupational Specialization among the Classic Maya at Tikál, Guatemala. In *Revista Espanola de Antropologia Americana XIII*, pp. 29-46, Madrid.
- Behm, J. A.
1983 Flake Concentrations: Distinguishing Between Flintworking Areas and Secondary Deposits. *Lithic Technology* 12(1):9-16.
- Berdan, F. F.
1980 Aztec Merchants and Markets: Local-level Economic Activity in a Non-industrial Empire. *Mexicon* 2(3):37-41.
1989 Trade and Markets in Precapitalist States. In *Economic Anthropology*, edited by S. Plattner, pp. 21-48. Stanford University Press, Stanford, CA.
- Binford, L. R.
1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Archaeological Research* 35(3):255-273.
- Black, S. L.
1987 Settlement Pattern Survey and Testing, 1985. In *Rio Azul Reports, No. 3: The 1985 Season*, edited by R. E. W. Adams, pp. 183-221. Center for Archaeological Research, The University of Texas at San Antonio.
- Black, S. L. and C. K. Suhler
1986 The 1984 Rio Azul Settlement Survey. In *Rio Azul Reports, No. 2: The 1984 Season*, edited by R. E. W. Adams, pp. 163-192. Center for Archaeological Research, The University of Texas at San Antonio.
- Blanton, R. E. and G. M. Feinman
1984 The Mesoamerican World System. *American Anthropologist* 86(3):673-682.
- Bleed, P.
1986 The Optimal Design of Hunting Weapons: Maintainability or Reliability. *American Antiquity* 51(4):737-747.
- Blom, F. F.
1932 Commerce, Trade and Monetary Units of the Maya. In *Middle American Papers, Publication 4*, pp. 531-556. Middle American Research Institute, Tulane University, New Orleans.
- Boxt, M. A.
1993 *Archaeological Inquiry at Sarteneja: A Report on Community Patterning*. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles.

Bozarth, S. R. and T. H. Guderjan

- 2003 Biosilicate Analysis of Residue in Maya Dedicatory Cache Vessels from Blue Creek, Belize. Manuscript on file, Department of Sociology, Anthropology, and Criminal Justice, Texas Christian University, Fort Worth.

Bradbury, A. P. and J. D. Franklin

- 2000 Raw Material Variability, Package Size, and Mass Analysis. *Lithic Technology* 25(1):42-58.

Brady, J. E. and W. Ashmore

- 1999 Mountains, Caves, Water: Ideational Landscapes of the Ancient Maya. In *Archaeologies of Landscape: Contemporary Perspectives*, edited by W. Ashmore and A. B. Knapp, pp. 124-145. Blackwell, Malden, MA.

Brainerd, G. W.

- 1958 *The Archaeological Ceramics of Yucatan*. Anthropological Records, No. 19. University of California Press, Berkeley.

Braswell, G. E.

- 2001 Ancient Economy and Alternative Approaches to Stone Tools at Copan, Honduras. *Latin American Antiquity* 12(2):217-220.
2002 Praise the Gods and Pass the Obsidian?: The Organization of Ancient Economy in San Martin Jilotepeque, Guatemala. In *Ancient Maya Political Economies*, edited by M. A. Masson and D. A. Freidel, pp. 285-306. AltaMira Press, New York.

Brokaw, N. V. L. and E. P. Mallory

- 1993 *Vegetation of the Rio Bravo Conservation and Management Area, Belize*. Manomet Bird Observatory, Massachusetts, and the Programme for Belize, Belize City, Belize.

Brumfiel, E. M.

- 1980 Specialization, Market Exchange, and the Aztec State: A View from Huexotla. *Current Anthropology* 21(4):459-478.
1983 Aztec State Making: Ecology, Structure, and Origin of the State. *American Anthropologist* 85(2):261-284.

Brumfiel, E. M. and T. K. Earle (editors)

- 1987a *Specialization, Exchange, and Complex Societies*. Cambridge University Press, Cambridge, England.

- 1987b Specialization, Exchange, and Complex Societies: An Introduction. In *Specialization, Exchange, and Complex Societies*, edited by E. M. Brumfiel and T. K. Earle, pp. 1-9. Cambridge University Press, Cambridge, England.

Brunhouse, R. L.

- 1976 *Frans Blom; Maya Explorer*. University of New Mexico Press, Albuquerque.

Bullard, W. R., Jr.

- 1960 Maya Settlement Pattern in Northeastern Petén, Guatemala. *American Antiquity* 25(3):355-372.
- 1964 Settlement Pattern and Social Structure in the Southern Maya Lowlands during the Classic Period. In *Proceedings of the International Congress of Americanists, Mexico* (35 session, Mexico, 1962). Vol. 1, pp. 279-287. Mexico City.

Buttles, P. J.

- 2002 *Material and Meaning: A Contextual Examination of Select Portable Material Culture from Colha, Belize*. Unpublished Ph.D. dissertation, Department of Anthropology, The University of Texas at Austin.

Cackler, P. R., M. D. Gascock, H. Neff, H. Iceland, K. A. Pyburn, D. Hudler, T. R. Hester and B. M. Chiarulli

- 1999 Chipped Stone Artefacts, Source Areas, and Provenance Studies of the Northern Belize Chert-bearing Zone. *Journal of Archaeological Science* 26(4):389-397.

Carneiro, R. L.

- 1992 Point Counterpoint: Ecology and Ideology in the Development of New World Civilizations. In *Ideology and Pre-Columbian Civilization*, edited by A. A. Demarest and G. W. Conrad, pp. 175-203. School of American Research Design, Santa Fe, NM.

Carr, H. S.

- 1996 Precolumbian Maya Exploitation and Management of Deer Populations. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*, edited by S. L. Fedick, pp. 251 - 261. University of Utah Press, Salt Lake City.

Chase, A. F. and D. Z. Chase

- 1998 Late Classic Maya Political Structure, Polity Size, and Warfare Arenas. In *Anatonia de una Civilizacion*, edited by A. C. Ruiz, Y. F. Marquinez, J. M. G. Campillo, J. I. Ponce de Leon, A. L. Garcia-Gallo and L. T. Sanz Castro, pp. 11-29. Sociedad Espanola de Estudios Mayas, Madrid.
- 2001 Ancient Maya Causeways and Site Organization at Caracol, Belize. *Ancient Mesoamerica* 12(2):273-281.

- Chase, D. Z. and A. F. Chase
 1988 *A Postclassic Perspective: Excavations at the Maya Site of Santa Rita Corozal, Belize*. Pre-Columbian Art Research Institute, San Francisco, CA.
 1992 *Mesoamerican Elites: An Archaeological Assessment*. University of Oklahoma Press, Norman.
 1998 The Architectural Context of Caches, Burials, and Other Ritual Activities for the Classic Period Maya (as Reflected at Caracol, Belize). In *Function and Meaning in Classic Maya Architecture*, edited by S. D. Houston, pp.299-332. Dumbarton Oaks. Washington, DC.
- Childe, G. V.
 1951 *Man Makes Himself*. Watts, London.
- Cioffi-Revilla, C. and T. Landman
 1999 Evolution of Maya Politics in Ancient Mesoamerican System [Review]. *International Studies Quarterly* 43(4):559-598.
- Claggett, H. L.
 1997 Household Archaeology at Chan Cahal: A Step beyond Functionalism. In *The Blue Creek Project: Working Papers from the 1996 Field Season*, edited by W. D. Driver, H. L. Claggett and H. R. Haines, pp. 61-69. Maya Research Program, San Antonio, TX.
- Clark, B.
 1991 *Political Economy: A Comparative Approach*. Praeger Publishers, Westport, CT.
- Clark, C. M. A.
 1999 Political Economy: Schools. In *Encyclopedia of Political Economy*, edited by P. A. O'Hara, pp. 868-875. Routledge, New York.
- Clark, J. and D. Bryant
 1991 The Production of Chert Projectile Points at Yerba Buena, Chiapas, Mexico. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 85 - 102. Prehistory Press, Madison, WI.
- Clark, J. E.
 1984 Formative Obsidian Exchange and the Emergence of Public Economies in Chiapas, Mexico. In *Trade and Exchange in Early Mesoamerica*, edited by K. G. Hirth, pp. 235-274. University of New Mexico Press, Albuquerque.
 1986 From Mountains to Molehills: A Critical Review of Teotihuacan's Obsidian Industry. In *Research in Economic Anthropology*, Supplement 2, edited by B. L. Isaac, pp. 23-74. JAI Press, Greenwich, CT.

- 1988 *The Lithic Artifacts of La Libertad, Chiapas, Mexico: An Economic Perspective*. Papers of the New World Archaeological Foundation, 52. Brigham Young University, Provo, UT.
- 1991a Flintknapping and Debitage Disposal among the Lacandon Maya of Chiapas, Mexico. In *The Ethnoarchaeology of Refuse Disposal*, edited by E. Staski and L. D. Sutro, pp. 63-88. Anthropological Papers, Vol. 42. Arizona State University, Tempe.
- 1991b Modern Lacandon Lithic Technology and Blade Workshops. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 251 - 266. Prehistory Press, Madison, WI.
- Clark, J. E. and M. Blake
- 1994 The Power of Prestige: Competitive Generosity and the Emergence of Rank Societies in Lowland Mesoamerica. In *Factional Competition and Political Development in the New World*, edited by E. M. Brumfiel and J. W. Fox, pp. 17-30. Cambridge University Press, Cambridge, England.
- Clark, J. E. and W. J. Parry
- 1990 Craft Specialization and Cultural Complexity. In *Research in Economic Anthropology*, Vol. 12, edited by B. L. Issac, pp. 289-346. JAI Press, Greenwich, CT.
- Clastres, P.
- 1977 *Society Against the State*. Blackwell, Oxford.
- Clayton, S. C.
- 2004 Investigations at Rosita, 2003: Toward Understanding the Socio-political Landscape of the Blue Creek Region, Northeastern Belize. In *2003 Season Summaries of the Blue Creek Regional Political Ecology Project, Upper Northwestern Belize*, edited by J. C. Lohse. Report submitted to the Institute of Archaeology, Belmopan, Belize.
- Clayton, S. C., L. Kosakowsky, and W. D. Driver
- 2002 *Rubbish or Ritual? Contextualizing a Problematical Deposit from the Maya of Blue Creek, Belize*. Paper presented at the 67th Annual Meeting of the Society for American Archaeology, Denver, CO.
- Coe, M. D.
- 1999 *The Maya*. Sixth edition. Thames and Hudson, London.
- Coe, M. D. and J. Kerr
- 1998 *The Art of the Maya Scribe*. Harry N. Abrams, New York.

Coe, W. R.

- 1959 *Piedras Negras Archaeology: Artifacts, Caches, and Burials*. University Museum Monographs. University of Pennsylvania, Philadelphia, PA.
- 1965 Caches and Offeratory Practices in the Maya Lowlands. In *Handbook of Middle American Indians, Volume 2*, edited by R. Wauchope and G. R. Willey, pp. 462-468. University of Texas Press, Austin.

Coggins, C., J. S. H. Brown and E. W. Andrews

- 1983 *The Stucco Decoration and Architectural Assemblage of Structure 1-sub, Dzibilchaltun, Yucatan, Mexico*. Middle American Research Institute, Tulane University, New Orleans.

Collins, M. B.

- 1975 Lithic Technology as a Means of Processual Inference. In *Lithic Technology: Making and Using Stone Tools*, edited by E. H. Swanson, pp. 15-34. Mouton Publishers, The Hague, The Netherlands.

Cook, S. F.

- 1947 The Interrelation of Population, Food Supply, and Building in Pre-Conquest Central Mexico. *American Antiquity* 13(1):45-52.

Costin, C. L.

- 1991 Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production. In *Archaeological Method and Theory*, edited by M. B. Schiffer, pp. 1-56. University of Arizona Press, Tucson.

Cowgill, G. C.

- 1962 An Agricultural Study of the Southern Maya Lowlands. *American Anthropologist* 64(2):273-286.

Cox, K. A. and R. A. Ricklis

- 1999 The Organization of Lithic Technology at Blue Creek: A Systemic Approach. In *The Blue Creek Project: Working Papers from the 1997 Season*, edited by W. D. Driver, H. R. Haines and T. H. Guderjan, pp. 85-93. Maya Research Program, San Antonio, TX.

Crabtree, D. E.

- 1966 A Stoneworker's Approach to Analyzing and Replicating the Lindenmeire Folsome. *Tebiwa* 9(1):3-39.
- 1972a The Cone Fracture Principle and the Manufacture of Lithic Materials. *Tebiwa* 15(2):29-42.
- 1972b An Introduction to Flintworking. *Occasional Papers of the Idaho State University Museum*, Pocatello, ID.

Culbert, T. P.

1973 *The Classic Maya collapse*. 1st ed. University of New Mexico Press, Albuquerque.

1990 Maya Political History and Elite Interaction: A Summary View. In *Classic Maya Political History: Hieroglyphic and Archaeological Evidence*, pp. 311 - 346. Cambridge University Press, Cambridge, England.

Dalton, George

1977 Aboriginal Economies in Stateless Societies. In *Exchange Systems in Prehistory*, edited by T. K. Earle and J. E. Ericson, pp.191-212. Academic Press, New York.

Davis, D. D.

1975 Patterns of Early Formative Subsistence in Southern Mesoamerica, 1500-1100 B.C. *Man* 10(1):41-59.

Demarest, A. A.

1992 Ideology in Ancient Maya Cultural Evolution: The Dynamics of Galactic Politics. In *Ideology and Pre-Columbian Civilizations*, edited by A. A. Demarest and G. W. Conrad, pp. 135-157. School of American Research Advanced Seminar Series. School of American Research Press, Santa Fe, NM.

1996 Closing Comment. *Current Anthropology* 37(5):821-824.

2000 Ideology in Ancient Maya Cultural Evolution: The Dynamics of Galactic Politics. In *The Ancients of Mesoamerica: A Reader*, edited by M. E. Smith and M. A. Masson, pp. 279 - 299. Blackwell Publishers, Malden, MA.

Demarest, A. A., M. O'Mansky, C. Woolley, V. Tuerenhout, T. Inomata, J. Palka and H. Escobedo

1997 Classic Maya Defensive Systems and Warfare in the Petexbatun Region: Archaeological Evidence and Interpretations. *Ancient Mesoamerica* 8(2):229-254.

DeMarrais, E., L. J. Castillo and J. D. Eaton

1996 Ideology, Materialization, and Power Strategies. *Current Anthropology* 37(1):15-31.

Denevan, W. M.

1982 Hydraulic Agriculture in the American Tropics: Forms, Measures, and Recent Research. In *Maya Subsistence: Studies in Memory of Dennis E. Puleston*, edited by K. V. Flannery, pp. 181-203. Academic Press, New York.

Diesing, P.

1982 *Science and Ideology in the Policy Sciences*. Aldine, New York.

- Dockall, J. E. and H. J. Shafer
 1993 Testing the Producer-Consumer Model for Santa Rita Corozal, Belize. *Latin American Antiquity* 4(2):158-179.
- Dreiss, M. L.
 1988 *Obsidian at Colha, Belize: A Technological Analysis and Distributional Study Based on Trace Element Data*. Papers of the Colha Project. Texas Archaeological Research Laboratory; Center for Archaeological Research, Austin, TX.
- Dreiss, M. L. and D. O. Brown
 1989 Obsidian Exchange Patterns in Belize. In *Prehistoric Maya Economies of Belize*, edited by P. A. McAnany and B. L. Isaac, pp. 57-90. Research in Economic Anthropology. Supplement 4. JAI Press, Greenwich, CT.
- Drennan, R. D.
 1984 Long Distance Transport in Prehispanic Mesoamerica. *American Anthropologist* 86(1):105-112.
- Driver, W. D.
 1999 Excavations in Plaza A. In *The Blue Creek Project: Working Papers from the 1997 Field Season*, edited by W. D. Driver, H. R. Haines and T. H. Guderjan, pp. 12-37. Maya Research Program, San Antonio, TX.
 2002 An Early Classic Colonnaded Building at the Maya Site of Blue Creek, Belize. *Latin American Antiquity* 13(1):63-84.
- Driver, W. D., H. R. Haines, H. L. Clagett and J. Baker
 1997 *The Blue Creek Project: Working Papers from the 1996 Field Season*. Maya Research Program, San Antonio, TX.
- Driver, W. D. and P. Wanyerka
 2002 Creation Symbolism in the Architecture and Ritual at Structure 3, Blue Creek, Belize. *Mexicon* 26(1):6-8.
- Drollinger, H. D.
 1989 *An Investigation of a Late Preclassic Maya Chert Workshop from Colhá, Belize*. Unpublished MA thesis, Texas A&M University, College Station.
- Dumond, D. E.
 1962 Swidden Agriculture and the Rise of Maya Civilization. *Southwestern Journal of Anthropology* 17(4):301-316.

Dunham, P. S.

- 1996 Resource Exploitation and Exchange among the Classic Maya: Some Initial Findings of the Maya Mountains Archaeological Project. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*, edited by S. L. Fedick, pp. 315 - 334. University of Utah Press, Salt Lake City.

Dunning, N. P.

- 1992 *Lords of the Hills: Ancient Maya Settlement in the Puuc Region, Yucatán, Mexico*. Monographs in World Archaeology, No. 15. Prehistory Press, Madison, WI.

Dunning, N. P. and T. Beach

- 1994 Soil Erosion, Slope Management and Ancient Terracing in the Maya Lowlands. *Latin American Antiquity* 5(1):51-69.

Dunning, N. P., D. J. Rue, T. Beach, A. P. Covich and A. Traverse

- 1998 Human-environment Interactions in a Tropical Watershed: The Paleoecology of Laguna Tamarindito, El Petén, Guatemala. *Journal of Field Archaeology* 25(2):139-151.

Dunning, N. P., V. L. Scarborough, F. J. Valdez, S. Luzzadder-Beach, T. Beach and J. G. Jones

- 1999 Temple Mountains, Sacred Lakes, and Fertile Fields: Ancient Maya Landscapes in Northwestern Belize. *Antiquity* 73(281):650-660.

Earle, T. K.

- 1977 A Reappraisal of Redistribution: Complex Hawaiian Chiefdoms. In *Exchange Systems in Prehistory*, edited by T. K. Earle and J. E. Ericson, pp. 213-232. Academic Press, New York.
- 1978 *Economic and Social Organization of a Complex Chiefdom: The Halelea District, Kauai, Hawaii*. Anthropological Papers No. 63. Museum of Anthropology, University of Michigan, Ann Arbor.
- 1981 Comment on Rice. Evolution of Specialized Production, a Trial Model. *Current Anthropology* 22(3):230-231.
- 1989 Specialization and the Production of Wealth: Hawaiian Chiefdoms and the Inka Empire. In *Specialization, Exchange, and Complex Societies*, edited by E. M. Brumfiel and T. K. Earle, pp. 64-75. Cambridge University Press, Cambridge, England.
- 1991a *Chiefdoms: Power, Economy, and Ideology*. School of American Research Advanced Seminar Series. Cambridge University Press, Cambridge, England.
- 1991b Property Rights and the Evolution of Chiefdoms. In *Chiefdoms: Power, Economy, and Ideology*, edited by T. K. Earle, pp. 71-99. Cambridge University Press, Cambridge, England.

- 1998 Property Rights and the Evolution of Hawaiian Chiefdoms. In *Property in Economic Context*, edited by R. C. Hunt and A. Gilman, pp. 89-118. Monographs in Economic Anthropology, No. 14. University Press of America, Inc., New York.
- Eaton, J. D.
- 1980 Investigations within the Main Plaza of the Monumental Center at Colhá. In *The Colhá Project, Second Season, 1980 Interim Report*, edited by T. R. Hester, J. D. Eaton and H. J. Shafer, pp. 145-161. Center for Archaeological Research, The University of Texas at San Antonio.
- 1991 Tools of Ancient Maya Builders. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 219 - 228. Prehistory Press, Madison, WI.
- Eaton, J. D., T. R. Hester and Fred Valdez, Jr.
- 1994 Notes on Eccentric Lithics from Colhá and northern Belize. In *Continuing Archaeology at Colhá, Belize*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 257-265. Texas Archaeological Research Laboratory, The University of Texas at Austin.
- Escoto, J. A. V.
- 1964 Weather and Climate of Mexico and Central America. In *Handbook of Middle American Indians: Natural Environment and Early Cultures*, Vol. 1, edited by R. Wauchope, pp. 187-215. University of Texas Press, Austin.
- Fash, W. L.
- 1991 *Scribes, Warriors, and Kings: The City of Copán and the Ancient Maya*. Thames and Hudson Ltd., London, England.
- Fash, W. L. and D. Stuart
- 1991 Dynastic History and Cultural Evolution at Copan, Honduras. In *Classic Maya Political History*, edited by T. P. Culbert, pp. 147 - 179. Cambridge University Press/School of American Research, Cambridge, England.
- Fedick, S. L. (editor)
- 1996 *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*. University of Utah Press, Salt Lake City.
- Fedick, S. L.
- 1991 Chert Tool Production and Consumption among Classic Period Maya Households. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 103 - 118. Prehistory Press, Madison, WI.

- 1996a Conclusion: Landscape Approaches to the Study of Ancient Maya Agriculture and Resource Use. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*, edited by S. L. Fedick, pp. 335 - 347. University of Utah Press, Salt Lake City.
- 1996b An Interpretive Kaleidoscope: Alternative Perspectives on Ancient Agricultural Landscapes of the Maya Lowlands. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*, edited by S. L. Fedick, pp. 107-131. University of Utah Press, Salt Lake City.
- Fedick, S. L., D. Reid and J. P. Mathews
- 1995 Preliminary Evidence for the Existence of a Regional Sacbé across the Northern Maya Lowlands. In *The View from Yalahau: 1993 Archaeological Investigations in Northern Quintana Roo, Mexico*, edited by S. L. Fedick and K. A. Taube, pp. 129-137. Field Report Series, Vol. 2. University of California, Riverside.
- Fisher, C. T. and T. L. Thurston
- 1999 Dynamic Landscapes and Socio-political Process: The Topography of Anthropogenic Environments in Global Perspective. *Antiquity* 73(281):630-631.
- Flannery, K. V.
- 1968 The Olmec and the Valley of Oaxaca: A Model for Inter-regional Interaction in Formative Times. In *Dumbarton Oaks Conference on the Olmec*, edited by E. P. Benson, pp. 79-110. Dumbarton Oaks, Washington, DC.
- Foias, A. E.
- 2002 At the Crossroads: The Economic Basis of Political Power in the Petexbatun Region. In *Ancient Maya Political Economies*, edited by M. A. Masson and D. A. Freidel, pp. 223-248. AltaMira Press, New York.
- Foias, A. E. and R. L. Bishop
- 1997 Changing Ceramic Production and Exchange in the Petexbatun Region, Guatemala: Reconsidering the Classic Maya Collapse. *Ancient Mesoamerica* 8(2):275-291.
- Ford, A.
- 1990 *Xaman, Chikin, Lakin, Nohol: The Ancient Maya of Belize: Their Society and Sites*. CORI/MesoAmerican Research Center University of California Santa Barbara, Santa Barbara.
- 1996 Critical Resource Control and the Rise of the Classic Period Maya. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*, edited by Scott L. Fedick, pp. 297 - 303. University of Utah Press, Salt Lake City.

Ford, A. and K. Olson

- 1989 Aspects of Ancient Maya Household Economy: Variation in Chipped Stone Production and Consumption. In *Prehistoric Maya Economies of Belize*, edited by P. A. McAnany, pp. 185-211. Research in Economic Anthropology, Supplement 4. JAI Press, Greenwich, CT.

Forman, R. T. T.

- 1995 *Land Mosaics: The Ecology of Landscapes and Regions*. Cambridge University Press, New York.

Fowler, W.

- 1991 Lithic Analysis as a Means of Processual Inference in Southern Mesoamerica: A Review of Recent Research. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 1 - 20. Prehistory Press, Madison, WI.

Fowler, W. R.

- 2001 Introduction: Recent Research on Maya Causeways. *Ancient Mesoamerica* 12(2):259.

Fox, J. W. and G. W. Cook

- 1996 Constructing Maya Communities: Ethnography for Archaeology. *Current Anthropology* 37(5):811-821.

Fox, J. W., G. W. Cook, A. F. Chase and D. Z. Chase

- 1996 Questions of Political and Economic Integration: Segmentary Versus Centralized States among the Ancient Maya. *Current Anthropology* 37(5):795-801.

Freidel, D. A.

- 1981 The Political Economics of Residential Dispersion among the Lowland Maya. In *Lowland Maya Settlement Patterns*, edited by W. Ashmore, pp. 371-382. University of New Mexico Press, Albuquerque.
- 1988 The Jade Ahau: Toward a Theory of Commodity Value in the Maya Civilization. In *Jade: New Geological and Cultural Interpretations*, edited by F. W. Lange, pp. 149-165. University of Utah Press, Salt Lake City.
- 1990 The Jester God: The Beginning and End of a Maya Royal Symbol. In *Vision and Revision in Maya Studies*, edited by F. S. Clancy and P. D. Harrison, pp. 67-76. University of New Mexico Press, Albuquerque.
- 1992 The Trees of Life: Ahau as Idea and Artifact in Classic Lowland Maya Civilization. In *Ideology and Pre-Columbian Civilizations*, edited by A. A. Demarest and G. W. Conrad, pp. 115-134. School of American Research Press, Santa Fe, NM.

- Freidel, D. A., K. Reese-Taylor and D. Mora-Marin
 2002 The Origins of Maya Civilization: The Old Shell Game, Commodity, Treasure, and Kingship. In *Ancient Maya Political Economies*, edited by M. A. Masson and D. A. Freidel, pp. 41-86. AltaMira Press, New York.
- Freidel, D. A. and V. L. Scarborough
 1982 Subsistence, Trade, and Development of the Coastal Maya. In *Maya Subsistence: Studies in Memory of Dennis E. Puleston*, edited by K. V. Flannery, pp. 131-155. Academic Press, New York.
- Freidel, D. A. and L. Schele
 1988 Kingship in the Late Preclassic Maya Lowlands: The Instruments and Places of Ritual Power. *American Anthropologist* 90(3):547-567.
- Freidel, D. A., L. Schele and J. Parker
 1993 *Maya Cosmos: Three Thousand Years on the Shaman's Path*. 1st ed. W. Morrow, New York.
- Fried, M. H.
 1967 *The Evolution of Political Society: An Essay in Political Economy*. Random House, New York.
- Fry, R. E. (editor)
 1980 *Models and Methods in Regional Exchange*, No. 1. Society for American Archaeology, Washington, DC.
- Fullagar, R. L. K.
 1991 The Role of Silica in Polish Formation. *Journal of Archaeological Science* 18(1):1-24.
- Garber, J.
 1985 Long Distance Trade and Regional Exchange at the Maya Community of Cerros in Northern Belize. *Mexicon* 7(1):13-16.
- Geertz, C.
 1973 *The Interpretation of Cultures*. Basic Books, New York.
 1980 *Negara: The Theatre State in Nineteenth-century Bali*. Princeton University Press, Princeton, NJ.
- Giacometti, A. A.
 2002 *The Role of Plaza Complexes in Hinterland Settlements at the Maya site of Blue Creek, Belize*. Unpublished MA thesis, Institute of Archaeology, University College London.

Gibson, E. C.

- 1982 Excavation of a Late Classic Maya Lithic Workshop near Maskall, Belize. In *Archaeology at Colha, Belize: The 1981 Interim Report*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 182-186. Center for Archaeological Research, University of Texas at San Antonio, San Antonio, TX.
- 1986 *Diachronic Patterns of Lithic Production, Use and Exchange in the Southern Maya Lowlands*. Unpublished Ph.D. dissertation, Department of Anthropology, Harvard University, Cambridge, MA.
- 1991 A Preliminary Functional and Contextual Study of Constricted Adzes from Northern Belize. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by Thomas R. Hester and Harry J. Shafer, pp. 229 - 238. Prehistory Press, Madison, WI.

Giddens, A.

- 1984 *The Constitution of Society: Outline of the Theory of Structuration*. University of California Press, Berkeley.

Gifford, J. C.

- 1976 *Prehistoric Pottery Analysis and the Ceramics of Barton Ramie in the Belize Valley*. Memoirs of the Peabody Museum of Archaeology and Ethnology, Vol. 18. Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, MA.

Gonzalez, J.

- 2004 Ixnoha Excavation Report, 2003. In *2003 Season Summaries of the Blue Creek Regional Political Ecology Project, Upper Northwestern Belize*. Report submitted to the Institute of Archaeology, Belmopan, Belize.

Grace, R.

- 1996 Use-wear Analysis: The State of the Art. *Archaeometry* 38(2):209-229.

Graham, E. A.

- 1987 Resource Diversity in Belize and Its Implications for Models of Lowland Maya Trade. *American Antiquity* 52(4):753-767.
- 2002 Perspectives on Economy and Theory. In *Ancient Maya Political Economy*, edited by M. A. Masson and D. A. Freidel, pp. 398-418. AltaMira Press, New York.

Graham, E. A. and D. M. Pendergast

- 1989 Excavations at the Marco Gonzalez Site, Ambergris Caye, Belize, 1986. *Journal of Field Archaeology* 16(1):1-16.

Grube, N., T. H. Guderjan and H. R. Haines

- 1994 Late Classic Architecture and Iconography at the Blue Creek Ruin, Belize. *Mexicon* 17(3):51-56.

Guderjan, T. H.

- 1991 *Maya Settlement in Northwestern Belize: The 1988 and 1990 Seasons of the Río Bravo Archaeological Project*. Maya Research Program and Labyrinthos, Culver City, CA.
- 1996 A Summary of Research at Blue Creek. In *Archaeological Research at Blue Creek, Belize: Progress Report of the Fourth (1995) Field Season.*, edited by T. H. Guderjan, W. D. Driver and H. R. Haines, pp. 5-23. Maya Research Program, San Antonio, TX.
- 1998 The Blue Creek Jade Cache: Early Classic Ritual in Northwestern Belize. In *The Sowing and the Dawning: Termination, Dedication, and Transformation in the Archaeological and Ethnographic Record of Mesoamerica*, edited by S. B. Mock, pp. 101 - 111. University of New Mexico Press, Albuquerque.
- 2001 Recreating the Cosmos: Early Classic Dedicatory Caches at Blue Creek. Manuscript on file, Department of Sociology, Anthropology, and Criminal Justice, Texas Christian University, Fort Worth, TX.
- 2002 Patterns of Maya Jade Disposal at Blue Creek, Belize. Manuscript on file, Department of Sociology, Criminal Justice, and Anthropology, Texas Christian University, Fort Worth, TX.

Guderjan, T. H., J. Baker and R. J. Lichtenstein

- 2003 Environmental and Cultural Diversity at Blue Creek. In *Heterarchy, Political Economy, and the Ancient Maya*, edited by V. L. Scarborough, F. J. Valdez and N. P. Dunning, pp. 77-91. University of Arizona Press, Tucson.

Guderjan, T. H. and W. D. Driver

- 1996 Introduction to the 1995 Field Season. In *Archaeological Research at Blue Creek, Belize: Progress Report of the Fourth (1995) Field Season*, edited by T. H. Guderjan, W. D. Driver and H. R. Haines, pp. 1-4. Maya Research Program, San Antonio, TX.
- 1999 Architecture and Ritual at Blue Creek. In *The Blue Creek Project: Working Papers from the 1997 Season*, edited by W. D. Driver, H. R. Haines and T. H. Guderjan, pp. 1-11. Maya Research Program, San Antonio, TX.

Guderjan, T. H., W. D. Driver and H. R. Haines (editors)

- 1996 *Archaeological Research at Blue Creek, Belize: Progress Report of the Fourth (1995) Field Season*. Maya Research Program, San Antonio, TX.

- Guderjan, T. H. and J. Garber
 1995 *Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize*. Maya Research Program and Labyrinthos, Culver City, CA.
- Guderjan, T. H., H. R. Haines, M. Lindeman, E. Ruble, D. Pastrana and P. Weiss
 1994 *Excavations at the Blue Creek Ruin, Northwestern Belize: 1993 Interim Report*. Maya Research Program, San Antonio, TX.
- Guderjan, T. H., R. J. Lichtenstein and C. C. Hanratty
 2003 Elite Residences at Blue Creek, Belize. In *Maya Palaces and Elite Residences: An Interdisciplinary Approach*, edited by J. J. Christie, pp. 13-45. University of Texas Press, Austin.
- Guderjan, T. H., M. Lindeman, E. Ruble, F. Salam and J. Yaeger
 1991 Archaeological Sites in the Rio Bravo Area. In *Maya Settlement in Northwestern Belize: The 1988 and 1990 Seasons of the Rio Bravo Archaeological Project*, edited by T. H. Guderjan, pp. 55-88. Labyrinthos, Culver City, CA.
- Hageman, J. B. and J. C. Lohse
 2003 Heterarchy, Corporate Groups, and Late Classic Resource Management in Northwestern Belize. In *Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula*, edited by V. L. Scarborough, F. J. Valdez, and N. P. Dunning, pp. 109-121. University of Arizona Press, Tucson.
- Haines, H. R.
 1999 Continuing Excavations at Structure 9. In *The Blue Creek Project: Working Papers from the 1997 Season*, edited by W. D. Driver, H. R. Haines and T. H. Guderjan, pp. 39-45. Maya Research Program, San Antonio, TX.
 2000 *Intra-site Obsidian Distribution and Consumption Patterns in Northern Belize and North-eastern Petén*. Unpublished Ph.D. dissertation, Institute of Archaeology, University College London.
- Halperin, R. H.
 1994 *Cultural Economies Past and Present*. University of Texas Press, Austin.
- Hamblin, N. L.
 1984 *Animal Use by the Cozumel Maya*. University of Arizona Press, Tucson.
- Hammond, N.
 1972 Obsidian Trade Routes in the Mayan Area. *Science* 178(4065):1092-1093.

- 1975 *Lubaantun, A Classic Maya Realm*. Peabody Museum Monographs, No. 2. Peabody Museum of Archaeology and Ethnology Harvard University, Cambridge, MA.
- 1976 Maya Obsidian Trade in Southern Belize. In *Maya Lithic Studies: Papers from the 1976 Belize Field Symposium*, edited by T. R. Hester and N. Hammond, pp. 71-81. Center for Archaeological Research, University of Texas at San Antonio, San Antonio, TX.
- 1990 Inside the Black Box: Defining Maya Polity. In *Classic Maya Political History: Hieroglyphic and Archaeological Evidence*, edited by T. P. Culbert, pp. 253 - 284. Cambridge University Press, Cambridge, England.
- 1991 Cuello Considered: Summary and Conclusion, In *Cuello: An Early Maya Community in Belize*, edited by N. Hammond, pp. 235-248. Cambridge University Press, Cambridge, England.
- 2001 A New Maya Stelae from La Milpa, Belize. *Antiquity* 75(288):267-268.

Hammond, N. and W. Ashmore

- 1981 Lowland Maya Settlement: Geographical and Chronological Frameworks. In *Lowland Maya Settlement Patterns*, edited by W. Ashmore, pp. 19-36. University of New Mexico Press, Albuquerque.

Hanratty, C.

- 2002 Excavations in the Structure 37 Plazuela. In *The Blue Creek Project: Working Papers from the 1998 and 1999 Field Seasons*, edited by T. H. Guderjan and R. J. Lichtenstein, pp. 73-80. Maya Research Program, Texas Christian University, Fort Worth, TX.

Hansen, R. D.

- 1992 *Archaeology of Ideology: A Study of Maya Preclassic Architectural Sculpture at Nakbe, Petén, Guatemala*. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles.

Harris, M.

- 1979 *Cultural Materialism: The Struggle for a Science of Culture*. Random House, New York.

Harrison, P. D.

- 1993 Aspects of Water Management in the Southern Maya Lowlands. In *Economic Aspects of Water Management in the Prehispanic New World*, edited by V. L. Scarborough and B. L. Isaac, pp. 71-119. Research in Economic Anthropology, Supplement 7. JAI Press, Greenwich, CT.

Harrison, P. D. and B. L. Turner (editors)

- 1978 *Pre-Hispanic Maya Agriculture*. 1st ed. University of New Mexico Press, Albuquerque.

Hay, C. A.

- 1978 *Kaminaljuyu Obsidian: Lithic Analysis and the Economic Organization of a Prehistoric Maya Chiefdom*. Unpublished Ph.D. dissertation, Pennsylvania State University, State College.

Hayden, B.

- 1987a *Lithic Studies among the Contemporary Highland Maya*. University of Arizona Press, Tucson.
- 1987b Past to Present Uses of Stone Tools and Their Effects on Assemblage Characteristics in the Maya Highlands. In *Lithic Studies among the Contemporary Highland Maya*, edited by B. Hayden, pp. 160-234. University of Arizona Press, Tucson.
- 1987c Traditional Metate Manufacturing in Guatemala Using Chipped Stone Tools. In *Lithic Studies among the Contemporary Highland Maya*, edited by B. Hayden, pp. 8-119. University of Arizona Press, Tucson.

Healy, P. F.

- 1983 An Ancient Maya Dam in the Cayo District, Belize. *Journal of Field Archaeology* 10(2):147-154.

Healy, P. F., J. D. H. Lambert, J. T. Arnason, and R. J. Hebda

- 1983 Caracol, Belize: Evidence of Ancient Maya Agricultural Terraces. *Journal of Field Archaeology* 10(4):397-410.

Healy, P. F., H. I. McKillop and B. Walsh

- 1984 Analysis of Obsidian from Moho Cay, Belize: New Evidence on Classic Maya Trade Routes. *Science* 225(4660):414-417.

Heizer, R. F., H. Williams and J. A. Graham

- 1965 Notes on Mesoamerican Obsidians and Their Significance in Archaeological Studies. In *Sources of Stones Used in Prehistoric Mesoamerican Sites*, pp. 94-103. Contributions of the University of California Archaeological Research Facility, Vol. 1, University of California, Berkeley.

Helms, M. W.

- 1993 *Craft and the Kingly Ideal*. University of Texas Press, Austin.

Henry, D. O.

- 1989 Correlations between Reduction Strategies and Settlement Patterns. In *Alternative Approaches to Lithic Analysis*, edited by D. O. Henry and G. H. Odell, pp. 139-155. Archaeological Papers, Vol. 1. American Anthropological Association, Washington, DC.

Hester, T. R.

- 1976 Belize Lithics: Forms and Functions. In *Maya Lithic Studies: Papers from the 1976 Belize Field Symposium*, edited by T. R. Hester and N. Hammond, pp. 11-19. Center for Archaeological Research, University of Texas at San Antonio.
- 1982 The Maya Lithic Sequence in Northern Belize. In *Archaeology at Colha, Belize: The 1981 Interim Report*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 39-59. Center for Archaeological Research, University of Texas at San Antonio.
- 1985 The Maya Lithic Sequence in Northern Belize. In *Stone Tool Analysis: Essays in Honor of Don E. Crabtree*, edited by M. Plew, J. Woods and M. Pavesic, pp. 187-210. University of New Mexico Press, Albuquerque.

Hester, T. R. and N. Hammond (editors)

- 1976 *Maya Lithic Studies: Papers from the 1976 Belize Field Symposium*. Center for Archaeological Research, Special Report 4. University of Texas at San Antonio.

Hester, T. R. and H. J. Shafer

- 1984 Exploitation of Chert Resources by the Ancient Maya of Northern Belize, Central America. *World Archaeology* 16(2):157-173.
- 1991 *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*. Monographs in World Archaeology, No. 1. Prehistory Press, Madison, WI.
- 1994 The Ancient Maya Craft Community at Colha, Belize and Its External Relationships. In *Village Communities in Early Complex Societies*, edited by S. E. Falconer and G. M. Schwartz, pp. 121-139. Smithsonian Institution Press, Washington, DC.

Hester, T. R., H. J. Shafer and T. Berry

- 1991 Technological and Comparative Analyses of the Chipped Stone Artifacts from El Pozito, Belize. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by Thomas R. Hester and Harry J. Shafer, pp. 67 - 84. Prehistory Press, Madison, WI.

Hicks, F.

- 1984 Rotational Labor and Urban Development in Prehispanic Tetzucoco. In *Explorations in Ethnohistory: Indians of Central Mexico in the Sixteenth Century*, edited by H. Harvey and H. J. Prem, pp. 147-174. University of New Mexico Press, Albuquerque.

Hinckley, K.

- 1997 *A Mennonite Landscape: The Blue Creek Community*. Occasional Papers of the Maya Research Program Occasional Paper 1. Maya Research Program, San Antonio, TX.

Hirth, K. G.

- 1984 *Trade and Exchange in Early Mesoamerica*. 1st ed. University of New Mexico Press, Albuquerque.
- 1992 Interregional Exchange as Elite Behavior: An Evolutionary Perspective. In *Mesoamerican Elites: An Archaeological Assessment*, edited by D. Z. Chase and A. F. Chase, pp. 18 - 29. University of Oklahoma Press, Norman.
- 1996 Political Economy and Archaeology: Perspectives on Exchange and Production. *Journal of Archaeological Research* 4(3):203-239.

Holdridge, L. R.

- 1947 Determination of World Plant Formations from Simple Climatic Data. *Science* 105(2727):367-368.

Holmes, W. H.

- 1919 *Handbook of Aboriginal American Antiquities. Part I, Introductory, The Lithic Industries*. Smithsonian Institution, Bureau of American Ethnology, Bulletin 60, Washington, DC.

Houk, B. A.

- 1996 *Late Classic Site Planning at Dos Hombres, Belize*. Unpublished Ph.D. dissertation, The University of Texas at Austin.
- 1997 Drawing the Line: Site Plans and Cultural Boundaries in Northwest Belize. Paper presented at the 62nd Annual Meeting of the Society for American Archaeology, Nashville, TN.

Hutson, S. R.

- 2002 Built Space and Bad Subjects: Domination and Resistance at Monte Alban, Oaxaca, Mexico. *Journal of Social Archaeology* 2(1):53-80.

Ingbar, E. E., M. L. Larson and B. A. Bradley

- 1989 A Nontypological Approach to Debitage Analysis. In *Experiments in Lithic Technology*, edited by D. S. Amick and R. P. Mauldin, pp. 117-136. British Archaeological Reports International Series 528. Oxford.

Inomata, T. and S. D. Houston

- 2000 *Royal Courts of the Ancient Maya*. Westview Press, Boulder, CO.

Johnson, A. W. and T. K. Earle

- 1987 *The Evolution of Human Societies: From Foraging Group to Agrarian State*. Stanford University Press, Stanford, CA.

Johnson, J. K.

- 1976 Long Distance Obsidian Trade: New Data from the Western Maya Periphery. In *Maya Lithic Studies: Papers from the 1976 Belize Field Symposium*, edited by T. R. Hester and N. Hammond, pp. 83-90. Center for Archaeological Research, The University of Texas at San Antonio.
- 1989 The Utility of Production Trajectory Modeling as a Framework for Regional Analysis. In *Alternative Approaches to Lithic Analysis*, edited by D. O. Henry and G. H. Odell, pp. 119-138. Archaeological Papers, Vol. 1. American Anthropological Association, Washington, DC.

Jones, G. D.

- 1998 *The Conquest of the Last Maya Kingdom*. Stanford University Press, Stanford, CA.

Keeley, L. H.

- 1977 *An Experimental Study of Microwear Traces on Selected British Paleolithic Implements*. Unpublished Ph.D. dissertation, School of Archaeology, Oxford University.
- 1980 *Experimental Determination of Stone Tool Uses: A Microwear Analysis*. Prehistoric Archeology and Ecology. University of Chicago Press, Chicago.

Kelly, R. L.

- 1988 The Three Sides of a Biface. *American Antiquity* 53(4):717-734.

Kepecs, S. and S. Boucher

- 1996 The Pre-Hispanic Cultivation of Rejolladas and Stone-lands: New Evidence from Northeast Yucatan. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*, edited by S. L. Fedick, pp. 69 - 91. University of Utah Press, Salt Lake City.

Kepecs, S., G. M. Feinman and S. Boucher

- 1994 Chichen Itza and its Hinterland: A World Systems Perspective. *Ancient Mesoamerica* 5(2):141-158.

Kidder, A. V.

- 1947 *The Artifacts of Uaxactun, Guatemala*. Publication No. 576. Carnegie Institute of Washington, Washington, DC.
- 1950 Introduction. In *Uaxactun, Guatemala: Excavations of 1931-1937*, edited by A. L. Smith, pp. 1-12. Publication 588. Carnegie Institution of Washington, Washington, DC.

King, E. M.

- 2000 *The Organization of Late Classic Lithic Production at the Prehistoric Maya Site of Colhá, Belize*. Unpublished Ph.D. dissertation, Department of Anthropology, University of Pennsylvania, Philadelphia.

King, E. M. and D. R. Potter

- 1994 Small Sites in Prehistoric Maya Socioeconomic Organization: A Perspective from Colha, Belize. In *Archaeological Views from the Countryside: Village Communities in Early Complex Societies*, edited by G. M. Schwartz and S. E. Falconer, pp. 64-90. Smithsonian Institution Press, Washington, DC.

Knapp, A. B. and W. Ashmore

- 1999 Archaeological Landscapes: Constructed, Conceptualized, Ideational. In *Archaeologies of Landscape: Contemporary Perspectives*, edited by W. Ashmore and A. B. Knapp, pp. 1-30. Blackwell Publishers Ltd., Malden, MA.

Kristiansen, K.

- 1991 Chieftdoms, States, and Systems of Social Evolution. In *Chieftdoms: Power, Economy, and Ideology*, edited by T. K. Earle, pp. 16-43. Cambridge University Press, Cambridge, England.

LeCount, L. J.

- 1999 Polychrome Pottery and Political Strategies in Late and Terminal Classic Lowland Maya Society. *Latin American Antiquity* 10(3):239-258.

Lee, T. A. and B. Hayden

- 1988 *Ethnoarchaeology among the Highland Maya of Chiapas, Mexico*. Papers of the New World Archaeological Foundation, No. 56. New World Archaeological Foundation, Brigham Young University, Provo, UT.

Lene, G. W.

- 1997 Geology of the Blue Creek Area. In *The Blue Creek Project: Working Papers from the 1996 Field Season*, edited by W. D. Driver, H. L. Clagett and H. R. Haines, pp. 13-17. Maya Research Program, San Antonio, TX.

Leslie, R. (editor)

- 1997 *A History of Belize: Nation in the Making*. 3rd edition. Cubola Publications, Benque Viejo del Carmen, Belize.

Lewenstein, S. M.

- 1987 *Stone Tool Use at Cerros: The Ethnoarchaeological and Use-wear Evidence*. 1st ed. University of Texas Press, Austin.

- 1991a Edge Angles and Tool Function among the Maya: A Meaningful Relationship? In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 207 - 218. Prehistory Press, Madison, WI.
- 1991b Woodworking Tools at Cerros. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 239 - 250. Prehistory Press, Madison, WI.
- Lewenstein, S. M. and J. Walker
 1984 Obsidian Chip / Manioc Grating Hypothesis. *Journal of New World Archaeology* 6(2):25-38.
- Lewis, B. S.
 1995 *The Role of Specialized Production in the Development of Sociopolitical Complexity: A Test Case from the Late Classic Maya*. Unpublished Ph.D. dissertation, University of California, Los Angeles.
- Lichtenstein, R. J.
 2000 *Settlement Zone Communities of the Greater Blue Creek Area*. Occasional Papers of the Maya Research Program, No. 2. Maya Research Program, Fort Worth, TX.
- Lindeman, M. and T. H. Guderjan
 1991 Notes on Stone Resource Procurement and Consumption. In *Maya Settlement in Northwestern Belize: The 1988 and 1990 Seasons of the Rio Bravo Archaeological Project*, edited by T. H. Guderjan, pp. 95-97. Labyrinthos, Culver City, CA.
- Linton, R.
 1962 Crops, Soils, and Culture in America. In *The Maya and Their Neighbors*, edited by R. J. Thurman, pp. 32-40. University of Utah Press, Salt Lake City.
- Lohse, J. C.
 2001 *The Social Organization of a Late Classic Maya Community: Dos Hombres, Northwestern Belize*. Unpublished Ph.D. dissertation, The University of Texas at Austin.
- Lohse, J. C., E. S. Cooper, J. H. Cooper, M. Wolf, K. Gardella, and K. A. Cox
 2002 *Aerial Survey and Photogrammetric Documentation of Ancient Maya Canals in Northwestern Belize*. Paper presented at the 68th Annual Meeting of the Society for American Archaeology, Milwaukee, WI.
- Loten, H. S. and D. M. Pendergast
 1984 *A Lexicon for Maya Architecture*. Archaeology Monograph 8. Royal Ontario Museum, Ontario.

Lucero, L. J.

- 1999 Water Control and Maya Politics in the Southern Maya Lowlands. In *Complex Politics in the Ancient Tropical World*, edited by E. A. Bacus and L. J. Lucero, pp. 35-50. Anthropological Papers, Vol. 9. American Anthropological Association, Washington, DC.

Luedtke, B. E.

- 1992 *An Archaeologist's Guide to Chert and Flint*. Institute of Archaeology, University of California, Los Angeles.

MacKinnon, J. J.

- 1989 *Spatial and Temporal Patterns of Prehistoric Maya Settlement, Procurement, and Exchange on the Coast and Cays of Southern Belize*. Unpublished Ph.D. dissertation, University of Wisconsin, Madison.

Magne, M. P. R.

- 1989 Lithic Reduction Stages and Assemblage Formation Processes. In *Experiments in Lithic Technology*, edited by D. S. Amick and R. P. Mauldin, pp. 15-32. British Archaeological Reports International Series 528. Oxford.

Maler, T.

- 1908-1910 *Explorations of the Upper Usumatsintla and Adjacent Region: Explorations in the Department of Peten, Guatemala*. Carnegie Institution of Washington, Publication no. 436, Contributions to American Archaeology, no. 8, pp.175-186. Washington, DC.

Malinowski, B.

- 1920 Kula: The Circulating Exchange of Valuables in the Archipelagoes of Eastern New Guinea. *Man* 51(2):97-105.

Mallory, J. K.

- 1986 "Workshops" and "Specialized Production" in the Production of Maya Chert Tools: A Response to Shafer and Hester. *American Antiquity* 51(1):152-158.

Mann, M.

- 1986 *The Sources of Social Power: A History of Power from the Beginning to A.D. 1760*, Vol. 1. Cambridge University Press, Cambridge, England.

Marcus, J. P.

- 1973 Territorial Organization of the Lowland Maya. *Science* 180(4089):911-916.
1976 *Emblem and State in the Classic Maya Lowlands: An Epigraphic Approach to Territorial Organization*. Dumbarton Oaks, Washington, DC.

- 1983 Lowland Maya Archaeology at the Crossroads. *American Antiquity* 48(3):454-488.
- 1993 Ancient Maya Political Organization. In *Lowland Maya Civilization in the Eighth Century A.D.*, edited by J. A. Sabloff and J. S. Henderson, pp. 111-184. Dumbarton Oaks, Washington, DC.
- Martin, S. and N. Grube
- 1995 Maya Superstates: How a Few Powerful Kingdoms Vied for Control of the Maya Lowlands During the Classic Period (AD 300-900). *Archaeology* 48(6):41-43.
- 2000 *Chronicle of the Maya Kings and Queens: Deciphering the Dynasties of the Ancient Maya*. Thames & Hudson, New York.
- Massey, V. K.
- 1989 *The Skull Remains from a Terminal Classic Skull Pit at Colhá, Belize*. Papers of the Colhá Project 3. Texas Archaeological Research Laboratory, The University of Texas at Austin and Department of Anthropology, Texas A&M University, College Station.
- Massey, V. K. and D. G. Steele
- 1997 A Maya Skull Pit from the Terminal Classic Period, Colhá, Belize. In *Bones of the Maya: Studies of Ancient Skeletons*, edited by S. L. Whittington and D. M. Reed, pp. 62 - 77. Smithsonian Institution Press, Washington, DC.
- Masson, M. A.
- 1989 *Lithic Production Changes in Late Classic Maya Workshops at Colhá, Belize: A Study of Debitage Variation*. Unpublished MA thesis, Florida State University, Tallahassee.
- 1993 *Changes in Maya Community Organization from the Classic to the Postclassic Periods: A View from Laguna de On, Belize*. Unpublished Ph.D. dissertation, The University of Texas at Austin.
- 2002 Introduction. In *Ancient Maya Political Economies*, edited by M. A. Masson and D. A. Freidel, pp. 1-30. AltaMira Press, New York.
- Masson, M. A. and D. A. Freidel (editors)
- 2002 *Ancient Maya Political Economies*. AltaMira Press, New York.
- Matheny, R. T.
- 1978 Northern Maya Lowland Water-Control Systems. In *Pre-Hispanic Maya Agriculture*, edited by P. D. Harrison and B. L. Turner, pp. 185-210. University of New Mexico Press, Albuquerque.
- Maudslay, A. P.
- 1889-1902 *Biologia Centrali-Americana: Archaeology*, 4 volumes. R. H. Porter and Dulau and Co., London.

Mauldin, R. P. and D. S. Amick

- 1989 Investigating Patterning in Debitage from Experimental Bifacial Core Reduction. In *Experiments in Lithic Technology*, edited by D. S. Amick and R. P. Mauldin, pp. 67-88. British Archaeological Reports International Series 528. Oxford.

McAnany, P. A.

- 1988 The Effects of Lithic Procurement Strategies on Tool Curation and Recycling. *Lithic Technology* 17(1):3-11.
- 1989a Economic Foundations of Prehistoric Maya Society: Paradigms and Concepts. In *Prehistoric Maya Economies of Belize*, edited by P. A. McAnany, pp. 347-372. Research in Economic Anthropology, Supplement 4. JAI Press, Greenwich, CT.
- 1989b Stone-tool Production and Exchange in the Eastern Maya Lowlands: The Consumer Perspective from Pulltrouser Swamp. *American Antiquity* 54(2):332-246.
- 1990 Water Storage in the Puuc Region of the Northern Maya Lowlands: A Key to Population Estimates and Architectural Variability. In *Precolumbian Population History in the Maya Lowlands*, edited by T. P. Culbert and D. S. Rice, pp. 263-284. University of New Mexico Press, Albuquerque.
- 1991 Structure and Dynamics of Intercommunity Exchange. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 271-293. Monographs in World Archaeology, No. 1. Prehistory Press, Madison, WI.
- 1993 The Economics of Social Power and Wealth among Eighth-Century Maya Households. In *Lowland Maya Civilization in the Eighth Century A.D.*, edited by J. A. Sabloff and J. S. Henderson, pp. 65-90. Dumbarton Oaks, Washington, DC.
- 1995 *Living with the Ancestors: Kinship and Kingship in Ancient Maya Society*. 1st ed. University of Texas Press, Austin.

McBrearty, S., L. Bishop, T. Plummer, R. Dewar and N. Conard

- 1998 Tools Underfoot: Human Trampling as an Agent of Lithic Artifact Edge Modification. *American Antiquity* 63(1):108-129.

McGuire, R. H.

- 1996 The Limits of World-Systems Theory for the Study of Prehistory. In *Pre-Columbian World Systems*, edited by P. N. Peregrine and G. M. Feinman, pp. 51-64. Monographs in World Archaeology, No.26. Prehistory Press, Madison, WI.

McKillop, H. I.

- 1980 *Moho Cay, Belize: preliminary investigations of trade, settlement, and marine resource exploitation*. Unpublished MA thesis, Department of Anthropology, Trent University, Peterborough, Ontario, Canada.
- 1995 Underwater Archaeology, Salt Production, and Coastal Maya Trade at Stingray Lagoon, Belize. *Latin American Antiquity* 6(3):214-228.

- 1996 Ancient Maya Trading Ports and the Integration of Long-distance and Regional Economies: Wild Cane Cay in South-coastal Belize. *Ancient Mesoamerica* 7(1):49-62.
- McSwain, R.
 1991 A Comparative Evaluation of the Producer-consumer Model for Lithic Exchange in Northern Belize, Central America. *Latin American Antiquity* 2(4):337-351.
- Meadows, R. K.
 2000 Archaeological Excavations at Group H: Investigating Craft Production and Domestic Architecture at Chan Chich, Belize. In *The 1998 and 1999 Seasons of the Chan Chich Archaeological Project*, edited by B. A. Houk, pp. 15-40. Papers of the Chan Chich Archaeological Project, Number 4. Mesoamerican Archaeological Research Laboratory, The University of Texas at Austin.
 2001 *Crafting K'awil: A Comparative Analysis of Maya Symbolic Flaked Stone Assemblages from Three Sites in Northern Belize*. Unpublished Ph.D. dissertation, Department of Anthropology, The University of Texas at Austin.
- Michaels, G. H.
 1987 *A Description and Analysis of Early Postclassic Lithic Technology at Colhá, Belize*. Unpublished MA thesis, Department of Anthropology, Texas A&M University, College Station.
 1994 The Early Postclassic at Colhá, Belize: A Summery Overview and Directions for Future Research. In *Continuing Archaeology at Colhá, Belize*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 129-136. Texas Archaeological Research Laboratory, The University of Texas at Austin.
- Michaels, G. H. and H. J. Shafer
 1994 Excavations at Operation 2037 and 2040. In *Continuing Archaeology at Colhá, Belize*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 117-128. Texas Archaeological Research Laboratory, The University of Texas at Austin.
- Michels, J. W.
 1979 *The Kaminaljuyu Chiefdom*. Pennsylvania State University Press, University Park.
- Miller, A. G.
 1983 *Highland-lowland Interaction in Mesoamerica: Interdisciplinary Approaches*. Dumbarton Oaks, Washington, DC.
- Millon, R. F.
 1955 *When Money Grows on Trees: A Study of Cacao in Ancient Mesoamerica*. Unpublished Ph.D. dissertation, Department of Anthropology, Columbia University, New York.

Mitchum, B.

- 1991 Lithic Artifacts from Cerros, Belize: Production, Consumption, and Trade. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 45 - 53. Prehistory Press, Madison, WI.

Mock, S. B.

- 1994a Destruction and Denouement during the Late-Terminal Classic: The Colhá Skull Pit. In *Continuing Archaeology at Colha, Belize*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 221-232. Texas Archaeological Research Laboratory, The University of Texas at Austin.
- 1994b *The Northern River Lagoon Site (NRL): Late to Terminal Classic Maya Settlement, Salt Making, and Survival on the Northern Belize Coast*. Unpublished Ph.D. dissertation, Department of Anthropology, The University of Texas at Austin.
- 1997 Monkey Business at Northern River Lagoon: A Coastal-inland Interaction Sphere in Northern Belize. *Ancient Mesoamerica* 8(2):165-183.

Moholy-Nagy, H.

- 1990 Misidentification of Mesoamerican Lithic Workshops. *Latin American Antiquity* 1(3):268-279.
- 1991 The Flaked Chert Industry of Tikál, Guatemala. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by Thomas R. Hester and Harry J. Shafer, pp. 189 - 202. Prehistory Press, Madison, WI.
- 1997 Middens, Construction Fill, and Offerings: Evidence for the Organization of Classic Period Craft Production at Tikál, Guatemala. *Journal of Field Archaeology* 24(3):293-313.

Morley, S. G.

- 1937-1938 *The Inscriptions of Petén*. Publication No. 437. Carnegie Institution of Washington, Washington, DC.

Moss, E. H.

- 1987 A Review of "Investigating Microwear Polishes with Blind Tests". *Journal of Archaeological Science* 14(4):473-481.

Neivens, M.

- 1991 Operations at the Site of Blue Creek. In *Maya Settlement in Northwestern Belize: The 1988 and 1990 Seasons of the Río Bravo Archaeological Project*, edited by T. H. Guderjan, pp. 51-54. Labyrinthos, Culver City.

Nelson, F. W.

- 1985 Summary of the Results of Analysis of Obsidian Artifacts from the Maya Lowlands. *Scanning Electron Microscopy* 2(2):631-649.

Nelson, M.

- 1987a Contemporary Specialization and Marketing of Manos and Metates in the Maya Highlands. In *Lithic Studies among the Contemporary Highland Maya*, edited by B. Hayden, pp. 148-159. University of Arizona Press, Tucson.
- 1987b Site Content and Structure: Quarries and Workshops in the Maya Highlands. In *Lithic Studies among the Contemporary Highland Maya*, edited by B. Hayden, pp. 120-147. University of Arizona Press, Tucson.

Netting, R. M.

- 1990 Population, Permanent Agriculture, and Politics: Unpacking the Evolutionary Portmanteau. In *Evolution of Political Systems*, edited by S. Upman, pp.21-61. Cambridge University Press, Cambridge, MA.
- 1993 *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture*. Stanford University Press, Stanford.

Odell, G. H.

- 2001 Stone Tool Research at the End of the Millenium: Classification, Function, and Behavior. *Journal of Archaeological Research* 9(1):45-100.

Odell, G. H. and F. Odel-Vereecken

- 1980 Verifying the Reliability of Lithic Use-Wear Assessments by 'Blind Tests': The Low-Power Approach. *Journal of Field Archaeology* 7(1):87-120.

Oppenheimer, F.

- 1975 *The State*. Free Life Editions, New York.

Orlove, B. S.

- 1986 Barter and Cash Sale on Lake Titicaca: A Test of Competing Approaches. *Current Anthropology* 27(2):85-106.

Oviedo y Valdez, Gonzalo Fernandez de

- 1951 Historia General y Natural de las Indias, islas y tierra-firme del mar océano, 4 vs. Seville, (1535). Madrid manuscript, original at Tozzer Library, Harvard University.

Paine, R. R. and A. Freter

- 1996 Environmental Degradation and the Classic Maya Collapse at Copan, Honduras (a.d. 600 - 1250): Evidence from Studies of Household Survival. *Ancient Mesoamerica* 7(1):37-47.

Pastrana, D. V.

- 1999 An Analysis of the Jades from the Structure 4 Shaft Cache. In *The Blue Creek Project: Working Papers from the 1997 Season*, edited by W. D. Driver, H. R. Haines and T. H. Guderjan, pp. 95-114. Maya Research Program, San Antonio, TX.

Pendergast, D. M.

- 1986 Stability through Change: Lamanai, Belize, from Ninth to the Seventeenth Century. In *Late Lowland Maya Civilization: Classic to Postclassic*, edited by J. A. Sabloff and E. W. Andrews V, pp. 223-250. University of New Mexico Press, Albuquerque.

Peregrine, P. N., G. M. Feinman and C. K. Chase-Dunn

- 1996 *Pre-Columbian World Systems*. Monographs in World Archaeology, No. 26. Prehistory Press, Madison, WI.

Plattner, S.

- 1989a Economic Behavior in Markets. In *Economic Anthropology*, edited by S. Plattner, pp. 209-221. Stanford University Press, Stanford, CA.
 1989b Markets and Marketplaces. In *Economic Anthropology*, edited by S. Plattner, pp. 171-208. Stanford University Press, Stanford, CA.

Pohl, M. D. (editor)

- 1985 *Prehistoric Lowland Maya Environment and Subsistence Economy*. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 77. Harvard University Press, Cambridge, MA.

Pohl, M. D.

- 1985 The Privileges of the Maya Elites: Prehistoric Vertebrate Fauna from Seibal. In *Prehistoric Lowland Maya Environment and Subsistence Economy*, edited by M. D. Pohl, pp. 133-146. Papers of the Peabody Museum of Archaeology and Ethnology. Vol. 77. Harvard University Press, Cambridge, MA.

Polanyi, K.

- 1944 *The Great Transformation*. Holt, Rinehart and Winston, New York.

Pollock, H. E. D.

- 1962 *Mayapan, Yucatan, Mexico*. Carnegie Institution of Washington, Washington, DC.
 1965 Architecture of the Maya Lowlands. In *Handbook of Middle American Indians, Volume 2*, edited by R. Wauchoppe and G. R. Willey, pp. 378-440. University of Texas Press, Austin.

Popson, C. P. and H. L. Clagett

- 1999 Excavations at Chan Cahal, Blue Creek: The 1997 Field Season. In *The Blue Creek Project: Working Papers from the 1997 Season*, edited by W. D. Driver, H. R. Haines and T. H. Guderjan, pp. 71-83. Maya Research Program, San Antonio, TX.

Potter, D. R.

- 1991 A Descriptive Taxonomy of Middle Preclassic Chert Tools at Colhá, Belize. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 21 - 30. Prehistory Press, Madison, WI.
- 1994 Strat 55, Operation 2012, and Comments on Lowland Maya Blood Ritual. In *Continuing Archaeology at Colha, Belize*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 31-37. Texas Archaeological Research Laboratory, The University of Texas at Austin.

Potter, D. R. and E. M. King

- 1995 A Heterarchical Approach to Lowland Maya Socioeconomies. In *Heterarchy and the Analysis of Complex Societies*, edited by R. M. Ehrenreich, C. L. Crumley and J. E. Levy, pp. 17-32. Archaeological Papers of the American Anthropological Association, Number 6. Arlington, VA.

Pressman, S. and R. Neill

- 1999 Political Economy. In *Encyclopedia of Political Economy*, edited by P. A. O'Hara, pp. 853-856. Routledge, New York.

Proskouriakoff, T.

- 1962 The Artifacts of Mayapan. In *Mayapan, Yucatan, Mexico*, edited by H. E. D. Pollock, pp. 321-442. Publication 619. Carnegie Institute of Washington, Washington, DC.

Puleston, D. E.

- 1971 An Experimental Approach to the Function of Classic Maya Chultuns. *American Antiquity* 36(3):322-335.

Raab, Mark, Robert F. Cande, and David W. Stahle

- 1978 Debitage Graphs and Archaic Settlement Patterns in the Arkansas Ozarks. *Mid-Continental Journal of Archaeology* 4:167-182.

Rands, R. L. and R. L. Bishop

- 1980 Resource Procurement Zones and Patterns of Ceramic Exchange in the Palenque Region, Mexico. In *Models and Methods in Regional Exchange*, edited by R. E. Fry, pp. 19-46. SAA Papers No. 1. Society for American Archaeology, Washington, DC.

Rathje, W. L.

- 1972 Praise the Gods and Pass the Metates: An Hypothesis of the Rise and Fall of Lowland Rainforest Civilizations in Mesoamerica. In *Contemporary Archaeology*, edited by M. P. Leone, pp.365-392. Southern Illinois University Press, Carbondale.

Reed, N.

- 1964 *The Caste War of Yucatan*. Stanford University Press, Stanford, CA.

Reents-Budet, D.

- 2001 Classic Maya Concepts of the Royal Court: An Analysis of Renderings on Pictorial Ceramics. In *Royal Courts of the Maya, Volume 1: Theory, Comparison, and Synthesis*, edited by T. Inomata and S. Houston, pp.195-233. Westview Press, Boulder, CO.

Reents-Budet, D., R. L. Bishop and B. MacLeod

- 1994 Painting Styles, Workshop Locations and Pottery Production. In *Painting the Maya Universe: Royal Ceramics of the Classic Period*, edited by D. Reents-Budet, pp. 164-233. Duke University Press, Durham, NC.

Renfrew, C.

- 1986 Introduction: Peer Polity Interaction and Socio-political Change. In *Peer Polity Interaction and Socio-political Change*, edited by C. Renfrew and J. F. Cherry, pp. 1-18. Cambridge University Press, Cambridge, England.

Renfrew, C. and J. F. Cherry

- 1986 *Peer Polity Interaction and Socio-political Change*. New Directions in Archaeology. Cambridge University Press, Cambridge, England.

Rice, D. S.

- 1993 Eighth-century Physical Geography, Environment, and Natural Resources in the Maya Lowlands. In *Lowland Maya Civilization in the Eighth Century A.D.*, edited by J. A. Sabloff and J. S. Henderson, pp. 273-298. Dumbarton Oaks, Washington, DC.

Rice, P. M.

- 1980 Petén Postclassic Pottery Production and Exchange: A View from Macanche. In *Models and Methods in Regional Exchange*, edited by R. E. Fry, pp. 67-82. SAA Papers No. 1. Society for American Archaeology, Washington, DC.
- 1987 Lowland Maya Pottery Production in the Late Classic Period. In *Maya Ceramics: Papers from the 1985 Maya Ceramic Conference, Part II*, edited by P. M. Rice and R. J. Sharer, pp. 525-543. British Archaeological Reports International Series 345(ii). Oxford.

Ricketson, O. G. J. and E. B. Ricketson

1937 *Uaxactun, Guatemala, Group E. 1926-1931*. Publication 477, Carnegie Institution of Washington, Washington, DC.

Roemer, E.

1984 *A Late Classic Maya Lithic Workshop from Colhá, Belize*. Unpublished MA thesis, Texas A&M University, College Station.

1991 *A Late Classic Workshop at Colhá, Belize*. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by Thomas R. Hester and Harry J. Shafer, pp. 55 - 66. Prehistory Press, Madison, WI.

Rots, V.

2003 *Towards an Understanding of Hafting: the Macro- and Microscopic Evidence*. *Antiquity* 77(298):805-815.

Rovner, I.

1975 *Lithic Sequences from the Maya Lowlands*. Unpublished Ph.D. dissertation, Department of Anthropology, University of Wisconsin, Madison.

1976 *Pre-Columbian Maya Development of Utilitarian Lithic Industries: The Broad Perspective from Yucatan*. In *Maya Lithic Studies: Papers from the 1976 Belize Field Symposium*, edited by T. R. Hester and N. Hammond, pp. 41-53. Center for Archaeological Research, University of Texas at San Antonio.

Rovner, I., S. M. Lewenstein and F. W. Nelson

1997 *Maya Stone Tools of Dzibilchaltún, Yucatán, and Becán and Chicanná, Campeche*. Middle American Research Institute Tulane University, New Orleans.

Roys, R. L.

1957 *The Political Geography of the Yucatan Maya*. Publication 613, Carnegie Institution of Washington, Washington, DC.

Ruz Lhuillier, A.

1965 *Tombs and Funerary Practices in the Maya Lowlands*. In *Handbook of Middle American Indians, Volume 2*, edited by R. Wauchope, pp. 441-461. University of Texas Press, Austin.

Sabloff, J. A.

1977 *Old Myths, New Myths: The Role of Sea Traders in the Development of Ancient Maya Civilization*. In *The Sea in the Pre-Columbian World*, edited by E. P. Benson, pp. 67-88. Dumbarton Oaks, Washington, DC.

1990 *The New Archaeology and the Ancient Maya*. Scientific American Library Series, No. 30. Scientific American Library: W.H. Freeman, New York.

Sabloff, J. A. and W. L. Rathje

1975 The Rise of a Maya Merchant Class. *Scientific American* 233(4):72-82.

Sahlins, M. D.

1972 *Stone Age Economics*. Aldine-Atherton, Chicago.

Sanders, W. T.

1956 The Central Mexican Symbiotic Region. In *Prehistoric Settlement Patterns in the New World*, edited by G. R. Willey, pp. 115-127. Viking Fund Publications in Anthropology, No. 23. Wenner-Gren Foundation for Anthropological Research, New York.

1962 Cultural Ecology of Nuclear Mesoamerica. *American Anthropologist* 64(1):34-44.

1992 Ranking and Stratification in Prehispanic Mesoamerica. In *Mesoamerican Elites: An Archaeological Assessment*, edited by D. Z. Chase and A. F. Chase, pp. 278 - 291. University of Oklahoma Press, Norman.

Sanders, W. T. and B. J. Price

1968 *Mesoamerica: The Evolution of a Civilization*. Random House, New York.

Saunders, N. J.

1994 Predators of Culture: Jaguar Symbolism and Mesoamerican Elites. *World Archaeology* 26(1):104-117.

Santone, L.

1993 *Demand Structure, Transport Costs, and Patterns of Intraregional Exchange: Aspects of the Prehistoric Lithic Economy of Northern Belize*. Unpublished Ph.D. dissertation, Department of Anthropology, The University of Texas at Austin.

1997 Transport Costs, Consumer Demand, and Patterns of Intraregional Exchange: A Perspective on Commodity Production and Distribution from Northern Belize. *Latin American Antiquity* 8(1):71-88.

Scarborough, V. L.

1993 Water Management in the Southern Maya Lowlands: An Accretive Model for the Engineered Landscape. In *Economic Aspects of Water Management in the Prehispanic World*, edited by V. L. Scarborough and B. L. Isacc, pp. 17-69. JAI Press, Greenwich.

1996 Reservoirs and Watersheds in the Central Maya Lowlands. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*, edited by S. L. Fedick, pp. 304 - 314. University of Utah Press, Salt Lake City.

1998 Ecology and Ritual: Water Management and the Maya. *Latin American Antiquity* 9(2):135-159.

- Scarborough, V. L., F. J. Valdez and N. P. Dunning (editors)
 2003 *Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula*. University of Arizona Press, Tucson.
- Schele, L.
 2000 Sacred Landscape and Maya Kingship. In *In the Breakout: The Origins of Civilization*, edited by M. Lamberg-Karlovsky, pp. 45-55. Monographs 9. Harvard University, Peabody Museum of Archaeology and Ethnology, Cambridge, MA.
- Schele, L. and P. Mathews
 1998 *The Code of Kings: The Language of Seven Sacred Maya Temples and Tombs*. Scribner, New York.
- Schele, L., M. E. Miller and J. Kerr
 1986 *The Blood of Kings: Dynasty and Ritual in Maya Art*. G. Braziller; Kimbell Art Museum, New York.
- Schortman, E. M.
 1989 Interregional Interaction in Prehistory. *American Antiquity* 54(1):52-65.
- Schortman, E. M. and P. A. Urban
 1996 Actions at a Distance, Impacts at Home: Prestige Good Theory and a Pre-Columbian Polity in Southeastern Mesoamerica. In *Pre-Columbian World Systems*, edited by P. N. Peregrine and G. M. Feinman, pp. 97-114. Monographs in World Archaeology, No. 26. Prehistory Press, Madison, WI.
- Schumann, W.
 1993 *Handbook of Rocks, Minerals, and Gemstones*. Translated by R. Bradshaw. Harper Collins Publishers, New York.
- Schusky, E. L. and T. P. Culbert
 1987 *Introducing Culture*. 4th edition. Prentice-Hall, Englewood Cliffs, NJ.
- Scott, J. C.
 1976 *The Moral Economy of the Peasant: Rebellion and Subsistence in Southern Asia*. Yale University Press, New Haven, CT.
- Semenov, S. A.
 1964 *Prehistoric Technology: An Experimental Study of the Oldest Tools and Artefacts from Traces of Manufacture and Wear*. Translated by M. W. Thompson. Harper & Row Publishers, New York.

Sen, A.

1981 *Poverty and Famines: An Essay on Entitlement and Deprivation*. Clarendon Press, Oxford.

1992 *Inequality Reexamined*. Harvard University Press, Cambridge, MA.

Service, E. R.

1962 *Primitive Social Organization: An Evolutionary Perspective*. Random House, New York.

1975 *Origins of the State and Civilization: The Process of Cultural Evolution*. Norton, New York.

Shafer, H. J.

1976 Belize Lithics: "Orange Peel" Flakes and Adze Manufacture. In *Maya Lithic Studies: Papers from the 1976 Belize Field Symposium*, edited by T. R. Hester and N. Hammond, pp. 21-34. Center for Archaeological Research, University of Texas at San Antonio.

1979a Experimental Studies at Colhá. In *The Colhá Project, 1979: A Collection of Interim Papers*, edited by T. R. Hester, pp. 132-137. Center for Archaeological Research, University of Texas at San Antonio.

1979b A Technologic Study of Two Maya Lithic Workshops at Colhá, Belize. In *The Colhá Project, 1979: A Collection of Interim Papers*, edited by T. R. Hester, pp. 28-78. Center for Archaeological Research, University of Texas at San Antonio.

1981 Maya Lithic Craft Specialization in Northern Belize. Paper presented at the 80th Annual Meeting of the American Anthropological Association, Los Angeles, CA.

1982a Maya Lithic Craft Specialization in Northern Belize. In *Archaeology at Colhá, Belize: The 1981 Interim Report*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 31-38. Center for Archaeological Research, University of Texas at San Antonio.

1982b A Preliminary Report on the Lithic Technology at Kichpanha, Belize. In *Archaeology at Colha, Belize: The 1981 Interim Report*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 167-181. Center for Archaeological Research, University of Texas at San Antonio.

1983 The Lithic Artifacts of the Pulltrouser Area: Settlements and Fields. In *Pulltrouser Swamp: Ancient Maya Habitat, Agriculture, and Settlement in Northern Belize*, edited by P. D. Harrison and B. L. Turner, pp. 212-245. University of Texas Press, Austin.

1985 A Technological Study of Two Maya Workshops at Colhá, Belize. In *Stone Tool Analysis: Essays in Honor of Don E. Crabtree*, edited by M. G. Plew, J. C. Woods and M. G. Pavesic, pp. 277-315. University of New Mexico Press, Albuquerque.

- 1991 Late Preclassic Formal Stone Tool Production at Colhá, Belize. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by Thomas R. Hester and Harry J. Shafer, pp. 31 - 44. Prehistory Press, Madison, WI.
- 1994 Community-Wide Lithic Craft Specialization in the Late Preclassic Lowland Maya. In *Continuing Archaeology at Colhá, Belize*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 25-30. Texas Archaeological Research Laboratory, The University of Texas at Austin.

Shafer, H. J. and T. R. Hester

- 1983 Ancient Maya Chert Workshops in Northern Belize. *American Antiquity* 48(3):519-543.
- 1986 Maya Stone Tool Craft Specialization and Production at Colhá, Belize: Reply to Mallory. *American Antiquity* 50(1):158-166.
- 1990 The Puleston Axe: A Late Classic Maya Hafted Tool from Northern Belize. In *Ancient Maya Wetland Agriculture: Excavations on Albion Island, Northern Belize*, edited by M. D. Pohl, pp. 279-294. Westview Press, Boulder, CO.
- 1991 Lithic Craft Specialization and Product Distribution at the Site of Colhá, Belize. *World Archaeology* 23(1):79-97.

Shafer, H. J. and F. M. Oglesby

- 1980 Test Excavations in a Colhá Debitage Mound: Operation 4001. In *The Colhá Project: Second Season, 1980 Interim Report*, edited by T. R. Hester, J. D. Eaton and H. J. Shafer, pp. 195-219. Center for Archaeological Research, University of Texas at San Antonio.

Sharer, R. J.

- 1994 *The Ancient Maya*. 5th edition. Stanford University Press, Palo Alto, CA.

Shatto, R. C. A.

- 1998 *Maritime Trade and Seafaring of the Precolumbian Maya*. Unpublished MA thesis, Department of Anthropology, Texas A&M University, College Station.

Shea, J. J., and Klenck, J. D.

- 1993 An Experimental Investigation of the Effects of Trampling on the Results of Lithic Microwear Analysis. *Journal of Archaeological Science* 20(2):175-194.

Sheets, P. D.

- 1975 Behavioral Analysis and the Structure of a Prehistoric Industry. *Current Anthropology* 16(3):369-391.
- 1976 Islands of Lithic Knowledge Amid Seas of Ignorance in the Maya Area. In *Maya Lithic Studies: Papers from the 1976 Belize Field Symposium*, edited by T. R. Hester and N. Hammond, pp. 1-9. Center for Archaeological Research, University of Texas at San Antonio.

Shook, E. M.

- 1958 *Tikal Reports*. The University Museum, University of Pennsylvania, Philadelphia.

Shott, M.

- 1989 On Tool-Class Use Lives and the Formation of Archaeological Assemblages. *American Antiquity* 54(1):9-30.

Sidrys, R. V.

- 1977 Mass-distance Measures for the Maya Obsidian Trade. In *Exchange Systems in Prehistory*, edited by T. K. Earle and J. E. Ericson, pp. 91-107. Academic Press, San Francisco.
- 1979 Use of Mayan Obsidian Sources through Time: Trace-Element Data from El Bálsamo, Guatemala. *Journal of Field Archaeology* 6(1):116-122.

Sieveking, G. and M. B. Hart

- 1983 *The Scientific Study of Flint and Chert*. Proceedings of the Fourth International Flint Symposium held at Brighton Polytechnic, 10-15 April 1983. Cambridge University Press, New York.

Silbernagel, J., S. R. Martin, M. R. Gale and J. Chen

- 1997 Prehistoric, Historic, and Present Settlement Patterns Related to Ecological Hierarchy in the Eastern Upper Peninsula of Michigan, U S A. *Landscape Ecology* 12(4):18.

Smith, A. L.

- 1950 *Uaxactun, Guatemala: Excavations of 1931-1937*. Publication 588, Carnegie Institution of Washington, Washington, DC.

Smith, A. L. and A. V. Kidder

- 1951 *Excavations at Nebaj, Guatemala*. Publication 594, Carnegie Institution of Washington, Washington, DC.

Smith, M. E.

- 1996 *The Aztecs*. Blackwell Publishers, Cambridge, MA.

Smith, R. E.

- 1955 *Ceramic Sequence at Uaxactun, Guatemala*. Middle American Research Institute Tulane University, New Orleans.
- 1971 *The Pottery of Mayapan, Including Studies of Ceramic Material from Uxmal, Kabah, and Chichen Itza*. Papers of the Peabody Museum of Archaeology and Ethnology, No. 66. Harvard University, Cambridge, MA.

Sollberger, J. B.

- 1977 Fracture Theory, Applied to Flaking Forces and Lithic Analysis. Paper presented at the Conference for Use-Wear, Simon Fraser University, Burnaby, British Columbia, Canada.

Stanchly, N.

- 1999 An Analysis of the Faunal Remains: The 1996 and 1997 Field Seasons. In *The Blue Creek Project: Working Papers from the 1997 Season*, edited by W. D. Driver, H. R. Haines and T. H. Guderjan, pp. 115-121. Maya Research Program, San Antonio, TX.

Stevens, R. L.

- 1964 The Soils of Middle America and Their Relation to Indian Peoples and Cultures. In *Handbook of Middle American Indians: Natural Environment and Early Cultures, Vol. 1*, edited by R. Wauchope, pp. 265-315. University of Texas Press, Austin.

Steward, J.

- 1960 *Theory of Culture Change*. University of Illinois Press, Urbana.

Stross, F. H., J. R. Weaver, G. E. A. Wyld, R. F. Heizer and J. A. Graham

- 1968 Analysis of Mesoamerican Obsidians by X-Ray Fluorescence and Neutron Activation Analysis. In *Contributions of the University of California Archaeological Research Facility*, pp. 59-79. vol. 5. Los Angeles.

Sullivan, A. P. and K. C. Rozen

- 1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50(4):755-779.

Sullivan, L. A.

- 2002 Dynamics of Regional Integration in Northwestern Belize. In *Ancient Maya Political Economies*, edited by M. A. Masson and D. A. Freidel, pp. 197-222. AltaMira Press, New York.

Tamayo, J. L. and R. C. West

- 1964 The Hydrography of Middle America. In *Handbook of Middle American Indians: Natural Environment and Early Cultures, Vol. 1*, edited by R. Wauchope, pp. 84-121. University of Texas Press, Austin.

Tambiah, S. J.

- 1977 The Galactic Polity: The Structure of Traditional Kingdoms of Southeast Asia. *Annals of the New York Academy of Sciences* 293:69-97.

Taylor, A. J.

- 1980 Excavations at Kunahmul. In *The Colha Project: Second Season, 1980 Interim Report*, edited by T. R. Hester, J. D. Eaton and H. J. Shafer, pp. 241-250. Center for Archaeological Research, University of Texas at San Antonio, San Antonio, TX.

Thompson, J. E. S.

- 1931 *Archaeological Investigations in the Southern Cayo District, British Honduras*. Anthropological Series 17(3), Field Museum of Natural History, Chicago.
- 1948 An Archaeological Reconnaissance in the Cotzumalhuapa Region, Escuintla, Guatemala. In *Contributions to American Anthropology and History*, Carnegie Institution of Washington, Publication 574, vol. IX, pp. 1-92. Washington, DC.
- 1954 *The Rise and Fall of Maya Civilization*. 1st ed. University of Oklahoma Press, Norman.
- 1963 *Maya Archaeologist*. 1st American ed. University of Oklahoma Press, Norman.
- 1966 *The Rise and Fall of Maya Civilization*. 2nd ed. University of Oklahoma Press, Norman.
- 1974 "Canals" of the Rio Candelaria Basin, Campeche, Mexico. In *Mesoamerican Archaeology: New Approaches*, edited by N. Hammond, pp. 297-302. University of Texas Press, Austin.

Thompson, J. E. S. and A. O. Shepard

- 1939 *Excavations at San Jose, British Honduras*. Publication 506, Carnegie Institution of Washington, Washington, DC.

Thompson, M.

- 1991 Flaked Celt Production at Becan, Campeche, Mexico. In *Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference*, edited by T. R. Hester and H. J. Shafer, pp. 143 - 154. Prehistory Press, Madison, WI.

Tobey, M. H.

- 1985 *Trace Element Investigations of Maya Chert from Belize*. Papers of the Colhá Project 1. Center for Archaeological Research, University of Texas at San Antonio.

Tobey, M. H., H. J. Shafer and M. W. Rowe

- 1994 Trace Element Investigations of Chert from Northern Belize. In *Continuing Archaeology at Colhá, Belize*, edited by T. R. Hester, H. J. Shafer and J. D. Eaton, pp. 267-276. Texas Conservation Research Laboratory, The University of Texas at Austin.

Tomka, S. A.

- 1989 Differentiating Lithic Reduction Techniques: An Experimental Approach. In *Experiments in Lithic Technology*, edited by D. S. Amick and R. P. Mauldin, pp. 137-162. British Archaeological Reports International Series 528. Oxford.

Totten, G.

- 1926 *Maya Architecture*. Maya Press, Washington, DC.

Tourtellot, G. and J. A. Sabloff

- 1972 Exchange Systems among the Ancient Maya. *American Antiquity* 37(1):126-135.

Tozzer, A. M.

- 1911 *A Preliminary Study of the Prehistoric Ruins of Tikál, Guatemala: A Report of the Peabody Museum Expedition, 1909-1910*. Memoirs of the Peabody Museum of American Archaeology and Ethnology, Vol. 5, No. 2. Harvard University, Cambridge, MA.
- 1941 *Landa's Relacion de Las Cosas de Yucatan: A Translation*. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University XVIII. Peabody Museum of American Archaeology and Ethnology, Harvard University, Cambridge, MA.
- 1957 *Chichen Itza and Its Cenote of Sacrifice; A Comparative Study of Contemporaneous Maya and Toltec*. Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, MA.

Tringham, R., G. Cooper, G. H. Odell, B. Voytek and A. Witman

- 1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. *Journal of Field Archaeology* 1(1/2):171-196.

Tripplett, K. and R. Magaña

- 1999 Environmental Assessment of Blue Creek: Preliminary List of Woody Tree Species Encountered in Region. Manuscript on file, Maya Research Program. Fort Worth, TX.

Tsirk, A.

- 1979 Regarding Fracture Initiations. In *Lithic Use-wear Analysis*, edited by B. Hayden, pp. 83-96. Academic Press, New York.

Turner, B. L.

- 1983 *Once Beneath the Forest: Prehistoric Terracing in the Rio Bec Region of the Maya Lowlands*. Dellplain Latin American Studies, No. 13. Westview Press, Boulder, CO.

- Turner, B. L. and P. D. Harrison (editors)
 1983 *Pulltrouser Swamp: Ancient Maya Habitat, Agriculture, and Settlement in Northern Belize*. University of Texas Press, Austin.
- Turner, B. L. and P. D. Harrison
 1978 Implications from Agriculture for Maya Prehistory. In *Pre-Hispanic Maya Agriculture*. University of New Mexico Press, Albuquerque.
- Turner, B. L. and W. C. Johnson
 1973 A Maya Dam in the Copan Valley, Honduras. *American Antiquity* 44(2):299-305.
- Turner, E. S., N. I. Turner and R. E. W. Adams
 1982 Volumetric Assessment, Rank Ordering and Maya Civic Centers. In *Lowland Maya Settlement Patterns*, edited by W. Ashmore, pp. 71-88. University of New Mexico Press, Albuquerque, NM.
- Valdez, F. J.
 1994 The Colhá Ceramic Complexes. In *Continuing Archaeology at Colhá, Belize*. Texas Archaeological Research Laboratory, The University of Texas at Austin.
- Valdez, F. J. and S. B. Mock
 1991 Additional Considerations for Prehispanic Salt Making in Belize. *American Antiquity* 56(3):520-525.
- VandenBosch, J. C.
 1999 *Lithic Economy and Household Interdependence among the Late Classic Maya of Belize*. Unpublished Ph.D. dissertation, Department of Anthropology, University of Pittsburgh.
- Wagner, P. L.
 1964 Natural Vegetation of Middle America. In *Handbook of Middle American Indians: Natural Environment and Early Cultures, Vol. 1*, edited by R. Wauchope, pp. 216-264. University of Texas Press, Austin.
- Wagstaff, J. M.
 1987 *Landscape and Culture: Geographical and Archaeological Perspectives*. B. Blackwell, Oxford and New York.
- Wallerstein, I.
 1974 *The Modern World-System*. Academic Press, New York.
 1980 *The Modern World-System II*. Academic Press, New York.
 1989 *The Modern World-System III*. Academic Press, Orlando.

Webster, D. L.

- 1989 *The House of the Bacabs, Copán, Honduras*. Studies in pre-Columbian Art & Archaeology, No. 29. Dumbarton Oaks, Washington, DC.
- 1993 The Study of Maya Warfare: What It Tells Us about the Maya and What It Tells Us about Maya Archaeology. In *Lowland Maya Civilization in the Eighth Century A.D.*, edited by J. A. Sabloff and J. S. Henderson, pp. 415-444. Dumbarton Oaks, Washington, DC.
- 1998 Warfare and Status Rivalry: Lowland Maya and Polynesian Comparisons. In *Archaic States*, edited by G. M. Feinman and J. P. Marcus, pp. 311-352. School of American Research, Santa Fe.
- 2000 The Not So Peaceful Civilization: A Review of Maya War. *Journal of World Prehistory* 14(1):65-119.
- 2002 *The Fall of the Ancient Maya: Solving the Mystery of the Maya Collapse*. Thames and Hudson, London.

Wedderburn, D. (editor)

- 1974 *Poverty, Inequality and Class Structure*. Cambridge University Press, Cambridge, England.

Weiss-Krejci, E. and T. Sabbas

- 2002 The Potential Role of Small Depressions as Water Storage Features in the Central Maya Lowlands. *Latin American Antiquity* 13(3):343-357.

Welsh, W. B. M.

- 1988 *An Analysis of Classic Lowland Maya Burials*. International Series 409. British Archaeological Reports, Oxford.

West, G.

- 2002 Ceramic Exchange in the Late Classic and Postclassic Maya Lowlands: A Diachronic Approach. In *Ancient Maya Political Economies*, edited by M. A. Masson and D. A. Freidel, pp. 140-196. AltaMira Press, New York.

West, R. C.

- 1964 Surface Configuration and Associated Geology of Middle America. In *Handbook of Middle American Indians: Natural Environment and Early Cultures, Vol. 1*, edited by R. Wauchope, pp. 33-83. University of Texas Press, Austin.

Whittaker, J. C.

- 1994 *Flintknapping: Making and Understanding Stone Tools*. 1st ed. University of Texas Press, Austin.

Wiessner, Polly

- 2002 The Vines of Complexity: Egalitarian Structures and the Institutionalization of Inequality among the Enga. *Current Anthropology* 43(2):233-269.

Wilk, R. R. and J. Wilhite, Harold L.

- 1991 The Community of Cuello: Patterns of Household and Settlement Change. In *Cuello: An Early Maya Community in Belize*, edited by N. Hammond, pp. 118 - 133. Cambridge University Press, Cambridge, England.

Wilken, G. C.

- 1987 *Good Farmers: Traditional Agricultural Resource Management in Mexico and Central America*. University of California, Berkeley.

Wiley, G. R.

- 1956 Problems Concerning Prehistoric Settlement Patterns in the Maya Lowlands. In *Prehistoric Settlement Patterns in the New World*, edited by G. R. Wiley, pp. 107-114. Publications in Anthropology, No. 23. Wenner-Gren Foundation for Anthropological Research, New York.
- 1972 *The Artifacts of Altar de Sacrificios*. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 64(1), Harvard University. Peabody Museum, Cambridge, MA.
- 1978 *Excavations at Seibal, Department of Peten, Guatemala, Number 1, Artifacts*. Memoirs of the Peabody Museum of Archaeology and Ethnology, Harvard University; v. 14, no. 1-3. Cambridge, MA.

Wiley, G. R., W. R. Bullard, J. B. Glass, J. C. Gifford and O. Elliot

- 1965 *Prehistoric Maya Settlements in the Belize Valley*. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 54, Harvard University. Peabody Museum, Cambridge, MA.

Wilson, E.

- 1980 Physical Geography of the Yucatan Peninsula. In *Yucatan: A World Apart*, edited by E. Moseley and E. Terry, pp. 5-40. University of Alabama Press, Tuscaloosa.

Winzler, S. and S. L. Fedick

- 1995 Ancient Wells and Water Resources of Naranjal and the Yahau Region. In *The View from Yalahau: 1993 Archaeological Investigations in Northern Quintana Roo, Mexico*, edited by S. L. Fedick and K. A. Taube, pp. 101-113. Field Report Series, Latin American Studies Program, No. 2. University of California, Riverside.

Wittfogel, K. A.

1972 The Hydraulic Approach to Pre-Spanish Mesoamerica. In *The Prehistory of the Teahuacan Valley*, Vol. 4, edited by R. S. MacNeish, pp. 59-80. University of Texas Press, Austin.

Wright, A. C. S., D. H. Romney, R. H. Arbuckle and V. E. Vial

1959 *Land in British Honduras, Report of the British Land Use Survey Team*. Colonial Research Publications 24, London.

APPENDIX A**A DESCRIPTION AND ANALYSIS OF FORMAL STONE TOOL TYPES
RECORDED IN EXCAVATIONS AT BLUE CREEK, BELIZE**

Large Oval Biface Celts



Figure 48: Large oval biface celts recovered in excavations at Blue Creek, Belize.

Large oval bifaces have been described by many other researchers working throughout the Lowlands (see Table 2). This tool form has been recovered in deposits dating to the Late Preclassic and Early Classic periods in northern Belize. At Blue Creek, large oval bifaces have been recovered in Early Classic through Terminal Classic deposits.

The technology of manufacture for large oval biface tool forms appears to vary based on the location of manufacture. Oval bifaces emanating from northern Belize workshops appear to have been crafted from bifacial reduction of macroflakes using hard hammer, moderately soft hammer, and pressure percussion techniques. Oval bifaces emanating from local or regional sources appear to have been crafted from bifacial reduction of tabular nodules. Local and regional forms also exhibit more extensive use of soft hammer reduction and finer edge retouch.

There were 28 large oval bifaces recovered in excavations at Blue Creek, of which only 5 were complete (Table 43). A range of material types were used for manufacturing this tool form, including chalcedony, chert-chalcedony blends, fine and coarse-grained cherts, and dolomite. Large oval bifaces were imported from NBCZ sources throughout the Classic period, and were only manufactured from local or regional lithic material during the Late Classic period, coincident with the waning importation of exotic utilitarian tool forms.

There is a great deal of similarity between this tool form and those described as celtiform bifaces, ovate subform. The main differences are the quality of manufacture, the presence of lateral edge retouch, and the length-to-thickness ratio of the tool form. Large oval bifaces are finely crafted, exhibit fine lateral retouch, and are noticeably thinner than celtiforms (Figure 48). The range of tasks engaged in by the two tool forms also appears to have been divergent.

Table 43: Large oval biface descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	5	148	464	313.60	132.253
LENGTH	5	129	220	184.80	40.874
WIDTH	5	64	70	67.40	2.702
THICKNESS	5	16	32	22.40	6.542
EDGE_ANGLE	25	40	85	64.40	12.275

Puleston Axe measured 220mm length, 73mm width, and 20mm thickness. Edge angle is between 50-60 degrees. Lateral edges slightly blunted by step flaking for hafting.

Based on macroscopic examination of large oval bifaces at Blue Creek, this tool type appears to have been used for a limited range of tasks. Distal edge attrition was the dominant form of modification observed, with a small number of tools showing lateral flake terminations related to use. Only two tools exhibited crushed distal margins, suggesting that this tool form was most frequently used on soft to medium-soft contact materials, or possibly soil.

More than half of these tools (n=16) exhibited polish along their distal margins. The depth of polish penetration toward medial areas on the tool form varied with an equal number exhibiting shallow and deep distal polish. Deep distal polish, resulting from more extensive penetration of the contact material, seems tentatively correlated with the tool form being brought into contact with soil; three tools exhibiting deep distal polish also displayed pitting and linear striations running perpendicular to the bit. A small number of tools (n=3) exhibited lateral edge attrition and polish, suggesting that large oval bifaces were also used for cutting in addition to chopping.

Several tools exhibited hafting polish on their lateral margins and medial surfaces. This polish was invariably light, and associated with subtle feather terminations when located along the lateral margins of the tool form. No edge grinding was observed along margins. A distinct discontinuation between distal polish and the lateral polish attributed to hafting was noted in all instances. The distribution of this polish is consistent with mortise hafting, as was described for the Puleston Axe (Figure 49; Shafer and Hester 1990:281).

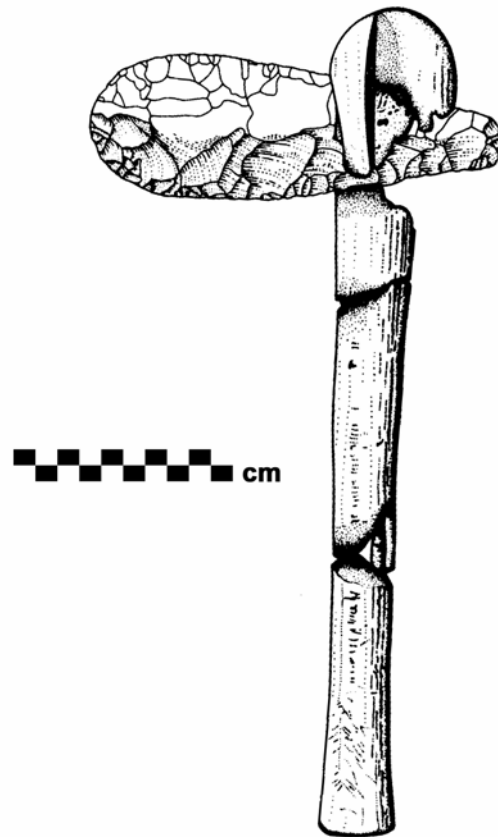


Figure 49: Hafted large oval biface recovered in excavations near San Antonio, Orange Walk District, Belize by Dennis Puleston (after Shafer and Hester 1990:280, Fig. 9.1).

Laurel Leaf Biface



Figure 50: Laurel leaf biface tool forms recovered in excavations at Blue Creek, Belize.

Laurel leaf bifaces have been recovered from sites throughout the lowlands, but are most commonly recovered at Petén, Pasion-Usumacinta, and Belize sites (Gibson 1986:129). The descriptive terminology used to describe these forms in early reports alludes to them as being either knives or spear points. Laurel leaf forms are typically found in Classic period deposits, and those recovered in excavations at Blue Creek are no exception. There were 19 laurel leaf bifaces recovered at Blue Creek, of which only 7 were complete (Table 44). The majority is constructed of FGB cherts from an unidentified exotic locality and date to the Late Classic period (Figure 50). Virtually all laurel leaf forms were constructed on fine-grained cherts. This was likely a requirement that would have facilitated the production of exceptionally thin tools with sharp, acute edges that were amenable to continuous resharpening.

There is a distinct difference in the manufacturing technology employed between NBCZ and FGB production zones in the fabrication of this tool form. Forms emanating from NBCZ workshops are slightly thicker and larger overall. They are manufactured from macroflakes and macroblades through moderately soft hammer percussion techniques. Edge finishing was accomplished through direct percussion. Forms emanating from FGB sources are thinner, have a greater width to length ratio, and exhibit a more acute edge angle. They too are crafted using macroflake blanks, but rely exclusively on soft hammer percussion techniques. Finishing was accomplished using pressure retouch.

Gibson (1986:129) has noted the existence of several laurel leaf biface subforms, including bi-pointed, proximally rounded, shallow corner notched, and straight based forms. Of these, the proximally rounded appears to be the most common at Blue Creek, with bi-pointed being the only other subform observed.

There has been a consistent failure to systematically distinguish between laurel leaf tool forms and lenticular tool forms in the literature (Barrett 1999). Hester et al. (1991:72-74) refer to laurel leaf forms as “lanceolate bifaces”, describing them as generally lenticular in shape, though distinct from the lenticular forms produced in northern Belize workshops in the Postclassic period. In northern Belize, lenticular bifaces date to the Postclassic period, while laurel leaf forms are found in Classic period (mainly Late Classic) contexts. In northwestern Belize above the Rio Bravo escarpment, and throughout the central lowlands, laurel leaf and lenticular forms each date to the Classic period. Each of these tool types is generally ovate to sub-ovate in outline. However, laurel leaf forms tend to have a greater width to length ratio, tend to be widest at their midpoint, and are often rounded at their base. Lenticular forms are typically more crudely crafted (though this is not true of the Postclassic forms produced in northern Belize workshops). Also, lenticular forms tend to be more narrow, exhibit straighter margins, and are commonly widest in their proximal quarter.

Table 44: Laurel leaf biface descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
WEIGHT	7	26	694	168.14	235.976	55684.810
LENGTH	7	88	348	175.14	86.210	7432.143
WIDTH	7	41	82	50.86	14.029	196.810
THICKNESS	7	5	23	11.00	5.972	35.667
EDGE_ANGLE	19	23	65	46.32	11.407	130.117

Based on macroscopic examination of use wear on laurel leaf forms from Blue Creek, this tool type was used exclusively as a knife for cutting or slicing. Bifacially-oriented edge attrition was invariably observed along the lateral margins. Several tools exhibited attrition at their distal bit. Distal attrition was always observed in addition to lateral edge modification, never exclusive of it. This suggests that laurel leaf tool forms were not used for piercing, as would be the case if these forms were utilized as weaponry. Most tools exhibited a shallow polish along their lateral margins indicating the area of use. Hafting polish was not explicitly observed, and nothing definitive regarding the technique of tool manipulation can be offered here. Finally, no tools showed edge crushing or linear striations.

Lenticular Biface



Figure 51: Lenticular biface tool forms recovered in excavations at Blue Creek, Belize.

Lenticular bifaces have been recovered in excavations throughout the lowlands; though they have been the subject of considerable terminological confusion (see Table 2; Figure 51). Lenticular forms are most often commingled with laurel leaf bifaces (see above), but several design characteristics indicate that a conceptual distinction between the forms existed for the artisans that created these forms. Lenticular bifaces have been recovered in Early and Late Classic period deposits throughout the central lowlands, and are common in northern Belize during the Early Postclassic. At Blue Creek, lenticular forms have been recovered in Late Preclassic deposits, representing one of the earliest occurrences of this tool type. Oddly, lenticular bifaces made from NBCZ cherts have been located at Blue Creek in Late Classic period deposits. According to Hester (1985),

northern Belize workshops did not begin producing this form prior to the Early Postclassic period. Lenticular bifaces continue to be utilized at Blue Creek through the Late Classic period.

Lenticular bifaces are typically bipointed, sub-ovate, and widest toward their proximal quarter. Distinct corners may be evident at the point of maximum width, though this is most typical of Postclassic forms. Hester (1985) has identified a “lozenge” subform that is characterized by a tapered, contracting stem. Lenticular bifaces are produced through bifacial reduction of tabular cores using hard and soft hammer techniques. Edges may be finely finished through pressure flaking, though this appears to be somewhat dependent on the quality of material used in their manufacture. Lenticular forms at Blue Creek crafted from local sedimentary quartzites did not show evidence of marginal pressure flaking. The majority of tools were crafted from locally or regionally available chalcedonies and coarse cherts, though tools made from imported fine-grained cherts were also used to a lesser degree.

A total of 46 lenticular bifaces were recovered in excavations at Blue Creek and the lithic workshop platform at Bedrock, of which only 5 were complete (Table 45). Many of those recovered at Bedrock were discarded production failures. Of those recovered outside of production contexts, a surprisingly large number of tools showed no use wear. When observed, most edge wear on was located along one or (more commonly) both lateral margins in a bifacial distribution. The most common pattern of polish formation observed was a shallow sheen developed along lateral margins. This pattern of edge attrition and polish strongly suggest that most lenticular bifaces were used as knives.

Table 45: Lenticular biface descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	5	12	110	66.80	36.431
LENGTH	5	73	142	109.20	25.994
WIDTH	5	25	41	34.80	6.017
THICKNESS	5	8	22	17.20	5.541
EDGE ANGLE	18	25	70	58.33	13.933

A small number of tools (n=3) displayed a distinctly dissimilar use wear pattern. Both attrition and polish were concentrated on the distal tip of these tools, suggesting that they were used for piercing. It is possible that lenticular bifaces were occasionally hafted and used as projectile points, and the form was certainly multifunctional. However, evidence suggests that they were predominantly used as knives.

Symmetrically Tapered Lenticular



Figure 52: Symmetrically tapered lenticular tool forms recovered in excavations at Blue Creek and Bedrock, Belize.

Symmetrically tapered lenticular forms are identical to what Gibson (1986:120-121) have called a “bifacial adze with narrow contracting stem” and what Hester (1982:47) has called “bipointed bifaces.” The largest collection of this form has been studied by Drollinger (1989), and the range of metric attributes recorded for the forms within this study compares favorably with Drollinger’s findings. A total of 11 tools were recovered, all but one coming from the lithic production platform at Bedrock (Table 46). The one specimen recovered within the Blue Creek settlement zone was found in excavations at the Rio Hondo precinct. This tool form is not likely to have been commonly imported to or crafted at Blue Creek. This may suggest that its function was specialized rather than being of general utility. Of the tools recovered, 6 were complete.

Symmetrically tapered lenticular forms have been recovered exclusively in Late Preclassic contexts in northern Belize (Drollinger 1989; Hester 1982; Shafer 1991). Each of the specimens within the present sample from the Bedrock lithic production platform similarly date to the Late Preclassic, though the one form discovered at Rio Hondo was within an Early Classic deposit.

These bifaces appear to have been made on macroflakes moderately-soft to soft hammer techniques. The form is bipointed with the maximum width occurring at approximately the midpoint of the object. The form is generally lenticular to slightly plano-convex in cross-section. A ridge is generally preserved along the longitudinal axis of the object which may serve to strengthen the blade (Figure 52). Pressure flaking may be observed along the distal and proximal lateral margins. Proximal margins are typically straight to slightly convex, while distal margins are often straight to slightly concave. Chert and chalcedony were used exclusively in manufacturing this tool form. The slender blade could not have been easily produced using the coarser grained raw materials available locally at Blue Creek or within the surrounding region.

Little can be said with regard to the function of this tool form based on the present study. All but one tool was recovered in a production context. The one tool located within a domestic context (in the Rio Hondo precinct at Blue Creek) showed

distal attrition and shallow distal polish. It was also found in association with a number of informal tools, most notably gravers and denticulates. It seems likely that this tool form served in some specialized craft industry, possibly as a gouge. It is highly unlikely that this tool form served as an adze as Gibson (1986:120-121) suggested.

Table 46: Symmetrically tapered lenticular descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	6	16	76	49.33	19.582
LENGTH	6	43	121	98.83	28.308
WIDTH	6	25	36	31.00	3.742
THICKNESS	6	16	22	18.83	2.317
EDGE_ANGLE	6	30	80	68.33	19.149

General Utility Biface

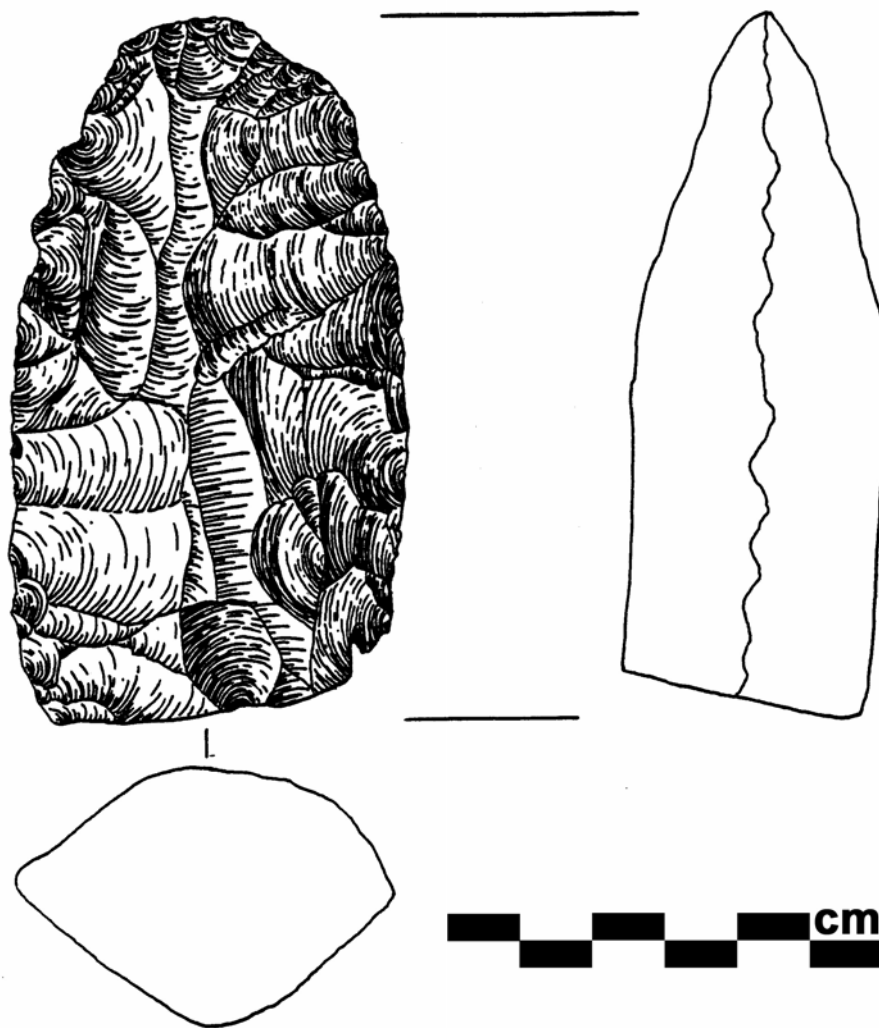


Figure 53: General utility biface (after Eaton 1980:158, Fig. 9).

General utility bifaces have been recovered throughout the Maya lowlands (see Gibson 1986:140). Their ubiquity, however, has not resulted in a standard terminology being used for their description. I use the terminology established by Hester (1985) in describing these tool forms. They are typically found in Late Classic period deposits,

but have been discovered in Late Preclassic deposits in the Belize Valley (Willey et al. 1965). At Blue Creek, this tool form has been found in Late Preclassic through Late Classic period deposits.

General utility bifaces are large-mass tool forms with a biconvex cross-section and an invariably straight, finely chipped distal bit. These bifaces are manufactured through bifacial reduction of cobbles using both hard and soft hammer percussion techniques. Considerable attention is given to producing the distal bit so that it is extraordinarily straight. Bits are finely retouched and generally beveled. At Blue Creek, the bits of many general utility bifaces are ground and polished (these are discussed in the section on ground-bit tool forms below). Grinding the bit was a greater labor investment, but it may have extended the use life of tools by making the bits stronger, requiring less refurbishing.

Two distinct subforms exist: the first is an elongate form that is fully ovate in outline; the second is a truncated form in which the proximal end is unfinished and partially removed (Figure 53). Hester (1982:48) has suggested that each of the subforms reflects the requirements of a different hafting technique. The elongate form may have been mortise hafted, similar to the Puleston Axe described above. The truncated form was likely hafted into a socket. Elongate forms were the most common type recovered at Blue Creek.

General utility bifaces were crafted from a variety of raw materials including local quartzites, dolomites, and coarse-grained cherts, regionally available chalcedonies, and imported NBCZ cherts. The majority of these tools were manufactured out of chalcedony or chert-chalcedony blends in workshops associated with the Dumbbell Bajo. Although Hester (1985) has stated that this tool form was only manufactured in northern Belize workshops during the Late Classic period, a general utility biface made from NBCZ chert was recovered in an Early Classic deposit at Blue Creek. This finding extends the production history of this tool form in northern Belize workshops back by a few centuries. A total of 47 tools were recovered in excavations at Blue Creek, Sotohob, and the workshop platform at Bedrock. Of these, 16 were complete (Table 47).

Table 47: General utility biface descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	16	218	500	359.94	91.271
LENGTH	16	77	147	106.56	18.630
WIDTH	16	58	85	70.06	7.019
THICKNESS	16	32	54	43.75	5.791
EDGE_ANGLE	23	70	125	95.65	13.425

Use wear analysis shows a clear tendency for general utility bifaces to exhibit distal edge attrition (observed on 19 specimens). A significant number of tools (n=14) exhibited crushed distal margins consistent with use against a medium-hard to hard contact material. A shallow distal polish was observed on several specimens (n=7), though rejuvenation efforts considerably limited the preservation of use polish. Two specimens exhibited lateral striations emanating at the distal bit. Significantly, 21 tools exhibited hafting polish about their midsections.

Based on analysis of use wear, Hester (1985) has stated that general utility bifaces were used as forest clearing tools. The wear pattern observed on the majority of forms from Blue Creek supports this conclusion. Gibson (1986:140-141) has also found evidence for their use in pounding and chiseling, and has offered that they may have been used as masonry tools. This supports the findings of Andrews and Rovner (1975) who recovered several similar tool forms within cache deposits in the northern lowlands. The crushed distal margins and lateral striations noted among a number of general utility bifaces at Blue Creek also supports the conclusion that these tools were used for masonry activities, including quarrying limestone. General utility bifaces were evidently multifunctional tools used for rugged tasks where the weight of the tool was a factor in its utility. The function the tool was selected to perform may have also impacted the decision to polish the distal bit. This is elucidated in greater detail below.

Ground-bit Bifaces

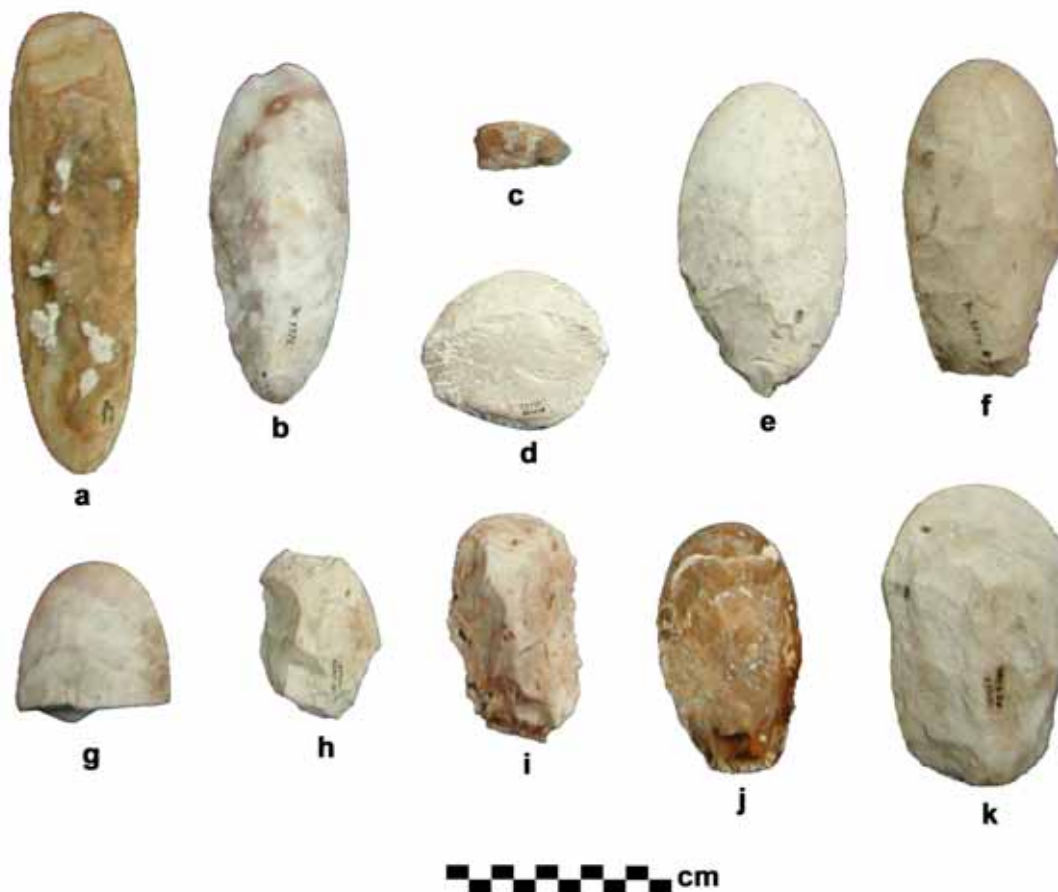


Figure 54: Ground-bit tool forms recovered in excavations at Blue Creek, Belize. (a) ground and polished celt; (b, d-k) polished-bit general utility bifaces; (c) ground and polished distal fragment.

Ground-bit bifaces have not been reported as such by archaeologists. My decision to separate ground and polished-bit tool forms as a distinct tool type was done for statistical purposes. However, the majority of these tool forms are morphologically and technologically identical to general utility bifaces and celtiform bifaces, save for the grinding and polishing of their distal bits (Figure 54). There is a tendency for ground-bit forms to be the elongate general utility biface subform, while flaked-bit forms are more

frequently the truncated subform. A total of 25 ground-bit bifaces were recovered in Classic period deposits at Blue Creek, Sotohob, and the lithic production platform at Bedrock (Table 48).

Interestingly, ground-bit forms seem to be almost invariably crafted out of comparatively inferior raw materials. Lithic materials used in manufacturing these forms include coarse cherts, quartz-chalcedony blends, chert-chalcedony blends, dolomite, and silicified limestone. These materials can not be flaked as easily or finely as fine-grained cherts, and the decision to polish the distal margin may have been an adaptation to using inferior raw materials. Another factor influencing the decision to expend additional energy in grinding and polishing the distal margin of these tool forms may have been a concern for greater durability.

Table 48: Ground-bit celtiform descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	8	222	824	502.75	199.605
LENGTH	8	101	170	136.13	24.074
WIDTH	8	58	88	72.38	10.716
THICKNESS	8	39	54	45.75	4.713
EDGE_ANGLE	8	80	90	87.50	3.780

Use wear analysis indicates that a significant portion of these tool forms were used against a medium-hard to hard contact material. The distal margins on 16 tools were crushed. This heavy battering may be indicative of quarrying or a related masonry function, or it may have resulted through contact with hardwoods over a long duration. Only two tools exhibited distal edge attrition. Many tools exhibited failure through distal torque fractures (bending fractures). Evidence of distal polish and etching was inconclusive as each are produced in the process of manufacturing the ground bit.

There are distinct differences in the patterns of wear observed on ground-bit bifaces and general utility bifaces. The most salient of these concerns the pattern of distal edge attrition recorded. Flaked-bit bifaces typically exhibit distal edge attrition in

the form of bifacial flaking or edge crushing. Conversely, ground-bit bifaces typically do not display a flaked attrition pattern, though many do exhibit crushing. This suggests that distal grinding was in fact performed as a way of limiting the damage incurred along the working of the tool during use. Thus, the Maya of Blue Creek adapted to the use of sub-optimal raw materials by investing greater energy into refurbishing ground and polished working edges on tool forms that experienced heavy impact during use. The poor quality raw materials would have made tool production difficult and limited the ease of capacity for recycling. Grinding the working bit of the tool would have produced a homogenous contact edge that was stronger and more durable than a flaked edge, thus extending the use-life of the tool.

A fragment of a whetstone used for grinding the bit of this tool form was discovered at Blue Creek, but was lost prior to photography. It matched the description of what Andrews and Rovner (1975:84, Fig. 4.9) have called “brick-shaped smoothers.” An elongate concave groove ran along on face, the dimensions of which perfectly matched the bit dimensions of several ground-bit celtiforms. The use of whetstones such as this accounts for the remarkable standardization in bit formation observed among these tool forms.

Celtiform Biface



Figure 55: Celtiform bifaces (ovate subform) recovered in excavations at Blue Creek, Belize.

Celtiform bifaces are the most common tool type in the Maya lowlands. They also suffer from the greatest amount of terminological inconsistency of perhaps any Maya formal tool type. Celtiforms are not associated with a given time period as they occur in deposits from the Middle Preclassic through the Late Postclassic. A total of 475

celtiform bifaces or biface fragments were recovered in excavations at Blue Creek, Sotohob, and the lithic production platform at Bedrock (Table 49). Only 46 tools were complete.

A variety of raw materials were used to construct celtiforms including chalcedony, chert-chalcedony blends, cherts of differing grain, dolomite, limestone, silicified limestone, and quartzite. Celtiforms were imported from northern Belize workshops and from regional production areas from the Late Preclassic through the Late Classic periods. Local raw materials were also used to construct celtiforms during this time.

Celtiform bifaces are manufactured through bifacial reduction of tabular cores or nodules using mainly hard hammer techniques through the finishing stage, at which point moderately soft hammer percussion is used. Celtiforms are rarely finished using pressure flaking, and seldom exhibit any retouch along their lateral margins (Figure 55). The expedient craftsmanship of this form is one of the major factors distinguishing it from large oval bifaces. Inferior raw material, including those with significant material flaws (see Figure 31) are frequently used in the production of these tool forms. As mentioned above, celtiforms are also generally thicker than large oval bifaces. Finally, celtiforms exhibit markedly steeper edge angles than oval bifaces, though their edge angles are more acute than those of general utility bifaces.

Table 49: Celtiform biface descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	46	96	424	175.24	59.488
LENGTH	46	61	140	102.02	17.959
WIDTH	46	45	86	58.98	7.022
THICKNESS	46	21	42	28.00	4.442
EDGE_ANGLE	177	40	120	80.48	12.567

Based on macroscopic examination of celtiform bifaces at Blue Creek, celtiform bifaces are generally used in a chopping motion. Of the celtiforms recovered that exhibited use wear, the majority (86.4%, n=152) exhibited edge attrition along their distal margin. The pattern of attrition suggests a direct-to-oblique chopping stroke. Many tools (37.5%, n=66) also exhibited crushed distal margins, indicating their use on medium-hard to hard contact materials. A smaller percentage (7.3%, n=13) exhibited lateral edge modification consistent with use, in addition to others (1.7%, n=3) showing crushed lateral margins.

Shallow distal polish was noted on 55 (31.3%) tools, and deep distal polish (exceeding 5mm from edge) was noted on another 23 (13.1%) tools. Use-derived polish was also noted along the lateral margins on 30 (17%) tools. Linear striations emanating from the distal bit were noted on 10 (5.9%) tools, suggesting that some celtiforms may have been used in working soil or quarrying.

These data suggest that celtiforms were certainly multifunctional tools used in a variety of contexts and on diverse contact materials. Diffuse polish located on medial faces and margins suggests that celtiforms were hafted in a similar fashion as large oval bifaces – though this would not have been the case with tools showing lateral edge wear. It is presently unclear how such tools would have been hafted for use.

Parallel-sided, Round-bit Celtiforms



Figure 56: Parallel-sided, round-bit celtiform tools recovered in excavations at Blue Creek, Belize.

Parallel-sided, round bit celts (PSRB celtiforms) have not been reported elsewhere in the lowlands. They are morphologically very similar to ovate celtiform bifaces, but their sides do not taper proximally as sharply (Figure 56). It remains possible that the parallel nature of the lateral margins on this tool form fall within the range of variability of ovate celtiforms. If that is the case then these do not actually represent a different variety of tool. The standardization in form observed is likely due to the majority of these forms being recovered within a specialized production deposit.

A total of 14 PSRB celtiforms are present in the current study sample (Table 50). All but one of these comes from the lithic production platform at Bedrock. Of those recovered at the production platform, 12 were incomplete (11 displayed medial snap fractures; 1 fractured from a material flaw). The one complete tool from the production platform was discarded in an early production stage due to platform collapse.

PSRB celtiforms are constructed through bifacial reduction of tabular cores. Hard hammer techniques dominate through the preform stage, at which point the majority of production is accomplished through soft hammer techniques. The attention given to finely flaking the distal and lateral margins through soft hammer and pressure flaking is dissimilar to that observed on ovate celtiforms. Production of each tool type is identical through early production stages. The degree of reliance on soft hammer percussion techniques appears to diverge following preform completion. Chalcedony and coarse grained chert was used in production of this tool form. As nearly all specimens recovered were incomplete production failures, no information on use wear is available. Furthermore, descriptive statistics are not provided due to the lack of complete tools.

Bifacial Points

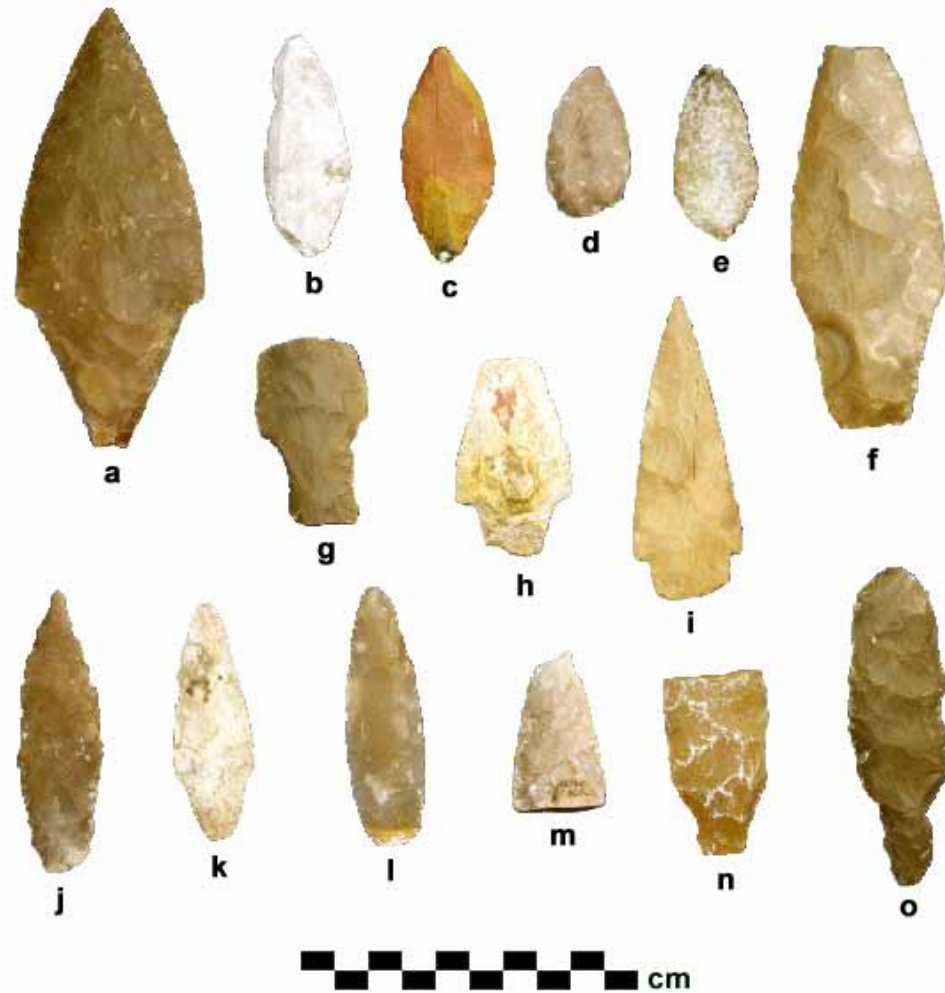


Figure 57: Biface point varieties recovered in excavations at Blue Creek, Belize. (a, h) squared shoulder with contracting stem; (b-e) lanceolate; (f, k, m) rounded shoulder with contracting stem; (g, n) angled shoulder with straight stem; (i) squared shoulder with straight stem; (j, l) lenticular; (m-o) unclassified.



Figure 58: Stemmed bifacial points recovered in Late Classic lithic cache at Blue Creek, Belize.

Bifacial points have been recovered from the majority of sites in the lowlands dating to all time periods. However, as yet there has been no systematic study of the spatial and temporal distribution forms for the lowlands as a whole (for regional chronologies see Hester 1985; Rovner et al. 1997). Those recovered at Blue Creek have been found in Late Preclassic, Early Classic, and Late Classic contexts.

A total of 50 bifacial points were recovered at Blue Creek (Figures 57 and 58). Of these, 34 were complete (Table 50). Interestingly, 80% (n=40) of all points were recovered in Late Classic period contexts. As only 41.4% (n=681) of all tool forms recovered at Blue Creek were found within Late Classic deposits, the preponderance of bifacial weapon forms during this period is not a product of sampling bias. Of all projectile points dating to the Late Classic period, 65% (n=26) were made of exotic FGB chert. The majority of these (n=21) were found within a cache deposit located in an elite plazuela above the escarpment (Figure 58). In addition to the stemmed bifaces, the cache deposit contained 20 obsidian blades, one very large laurel leaf biface, and one tri-

pronged, perforated eccentric. None of the cache artifacts exhibited use wear, suggesting that their function was purely ceremonial. The bifacial, stemmed points within the cache displayed remarkable standardization in design attributed, with very little deviation in length, width, thickness, and edge angle.

A variety of manufacturing techniques are observed in the bifacial point collection at Blue Creek. Points were constructed from tabular cores, from macroflakes, and from macroblades. Soft hammer techniques were used predominantly on all point forms, with pressure flaking noted along almost all lateral margins. No forms exhibit edge grinding. Beveling along the lateral margins was observed on each of the stemmed bifaces located within the Late Classic cache described above, but this was not a feature noted on the majority of bifacial points. Fine-grained cherts and chalcedonies were used preferentially in producing bifacial points.

Table 50: Bifacial point descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	34	10	90	49.00	22.505
LENGTH	34	16	140	97.68	26.854
WIDTH	34	24	60	44.41	10.526
THICKNESS	34	5	38	11.85	5.641
EDGE_ANGLE	30	40	65	56.83	4.997

Based largely on ethnographic analogy, there is a general assumption in the literature that bifacial points represent weapon forms used in hunting or warfare. Among the bifacial points in the study sample, 16 displayed edge modification and 12 exhibited marginal polish. The edge modification noted most frequently was distal-lateral attrition, showing that the tip and blade margins were each points of contact. The pattern of polish formation noted most frequently was shallow lateral polish, followed by shallow distal polish. While it is possible that bifacial points were used as knives, the data available can not reject their use as weaponry.

Side and Basal-notched Arrow Points



Figure 59: Side and basal-notched Postclassic arrow points recovered in excavations at Blue Creek, Belize.

Arrow points have been found throughout the lowlands (Figure 59). They are typically recovered in ephemeral contexts, and are more often than not Late Postclassic in date. A total of 13 non-obsidian arrow points were recovered from Blue Creek (Table 51). Most were located in compromised or near-surface contexts. The presence of this tool form at Blue Creek implies that the site was minimally visited if not modestly occupied during the Postclassic period. This assessment has not been corroborated by ceramic or architectural data, but it finds support from additional lithic data. A single triangular biface was also recovered at Blue Creek (see Figure 60 below). The biface

was made of NBCZ chert, but was not a production form at northern Belize workshops until the late facet of the Early Postclassic period (Hester 1982).

The majority of arrow points were made on flakes by pressure flaking, though a small number were produced on blades. Side and basal notches are typical features of Postclassic Maya arrow points (Gibson 1986:147). Only the side-notched variety have been recorded at Blue Creek (this does not include obsidian forms). The blade margins are straight to slightly convex and are invariably beveled and unifacially retouched. Raw materials used in the construction of arrow points include chalcedony and fine grained chert.

Table 51: Arrow point descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	6	2	2	2.00	.000
LENGTH	6	27	45	30.83	6.998
WIDTH	6	12	14	13.17	.753
THICKNESS	6	2	4	3.17	.753
EDGE_ANGLE	6	20	70	53.33	20.897



Figure 60: Triangular biface recovered in excavations at Blue Creek. The biface is made from northern Belize chert and was likely produced in Postclassic workshops at Colhá.

Stemmed Macroblade



Figure 61: Stemmed macroblades recovered in excavations at Blue Creek and Bedrock, Belize.

Stemmed macroblades have been recovered at many archaeological sites throughout the Maya lowlands (Clark 1988; Gibson 1986; Hester and Shafer 1994; Santone 1997). The vast majority were produced at the site of Colhá from the Late Preclassic through Late Classic periods. Macroblades were circulated through long-distance trade and occur as both utilitarian tools in domestic deposits and generally unused ceremonial tools in cache deposits and burials. A total of 6 artifacts in the Blue Creek formal tool assemblage were classified as stemmed macroblades (Figure 61). Another 35 artifacts were classified as macroblades. Many of the macroblades may have actually been stemmed, but they could not be classified as such as they lacked a hafting

element. Many of the incomplete forms showed that these tools were heavily recycled. Only 2 stemmed macroblades in the sample were complete (Table 52). Each of these was found in cache deposits.

Stemmed macroblades are triangular to sub-triangular in outline, typically exhibiting straight to somewhat angled shoulders and a slightly tapered stem. Production begins with the detachment of a macroflake from specially prepared cores. These macroflakes display a pronounced dorsal ridge that bisects the distal blade. The proximal portion of the blade is crafted into the stem of the tool form through bifacial reduction. The blade is prepared through primarily unifacial retouch along the dorsal surface, producing marginal edges that taper to a distal point. Stemmed macroblades are most often crafted using fine grained cherts, although on specimen made from western *bajo* chalcedony was also recovered at Blue Creek. Although rare, macroblades made outside of northern Belize workshops using local raw materials have been reported elsewhere (Gibson 1986:123).

Use wear analysis on these tool forms has shown that they were used to both cut and pierce (Dockall and Shafer 1993; Shafer 1983). The two cache specimens show evidence of light use, and the pattern of wear is consistent with piercing. Macroblade fragments found outside of cache deposits – presumably representing more utilitarian forms – exhibit extensive wear along their lateral margins and extensive recycling. Utilitarian forms at Blue Creek were likely to have been frequently used for cutting.

Table 52: Stemmed macroblade descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	2	50	157	103.50	75.660
LENGTH	2	140	199	169.50	41.719
WIDTH	2	40	88	64.00	33.941
THICKNESS	2	11	17	14.00	4.243
EDGE_ANGLE	2	30	45	37.50	10.607

Triangular Adze

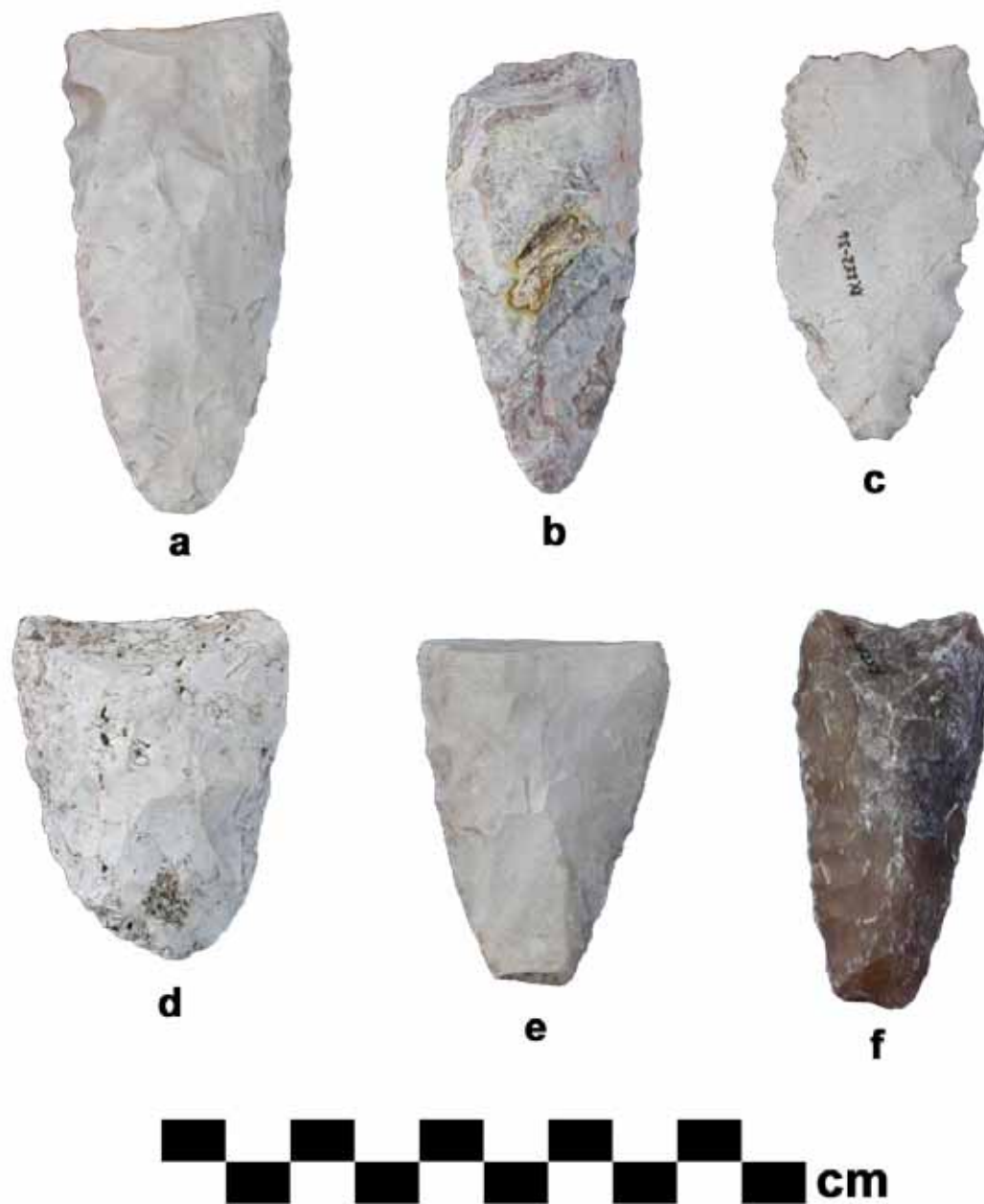


Figure 62: Small *ad hoc* triangular adze tool forms recovered in excavations at Blue Creek, Belize. (a-c, e) lenticular; (d, f) plano-convex.

It is currently unclear whether these are actually formal tools. I believe that they actually represent *ad hoc* tool forms based on the diversity observed in their metric attributes. There appears to be little standardization of form. Regardless of their origins, each has a beveled distal facet that displays edge attrition and polish (Figure 62). These tools are either lenticular or plano-convex in cross-section and approximately triangular in outline.

The common pattern of distal attrition noted is that of feather terminations favoring one face of the bit over the other. Distal polish is typically shallow. This wear pattern suggests that these tools were used for adzing a medium-soft to medium-hard contact material.

Ad hoc adzes have been located in Late Preclassic through Late Classic period deposits. They are not a common tool form. A total of 9 were recovered, and all but one was located at the Bedrock lithic production platform (Table 53). This lends further support to the assertion that these served as *ad hoc* tools. Most were likely salvaged from biface production failures. Chalcedony, chert-chalcedony blends, and coarse chert were used in their fabrication.

Table 53: *Ad hoc* adze descriptive statistics.

	<i>N</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Mean</i>	<i>Std. Deviation</i>
WEIGHT	6	38	150	68.33	41.635
LENGTH	6	64	103	86.50	15.502
WIDTH	6	31	75	44.50	16.183
THICKNESS	6	14	23	17.33	3.077
EDGE_ANGLE	6	40	60	45.83	7.360

Ground-bit, Plano-convex Planer

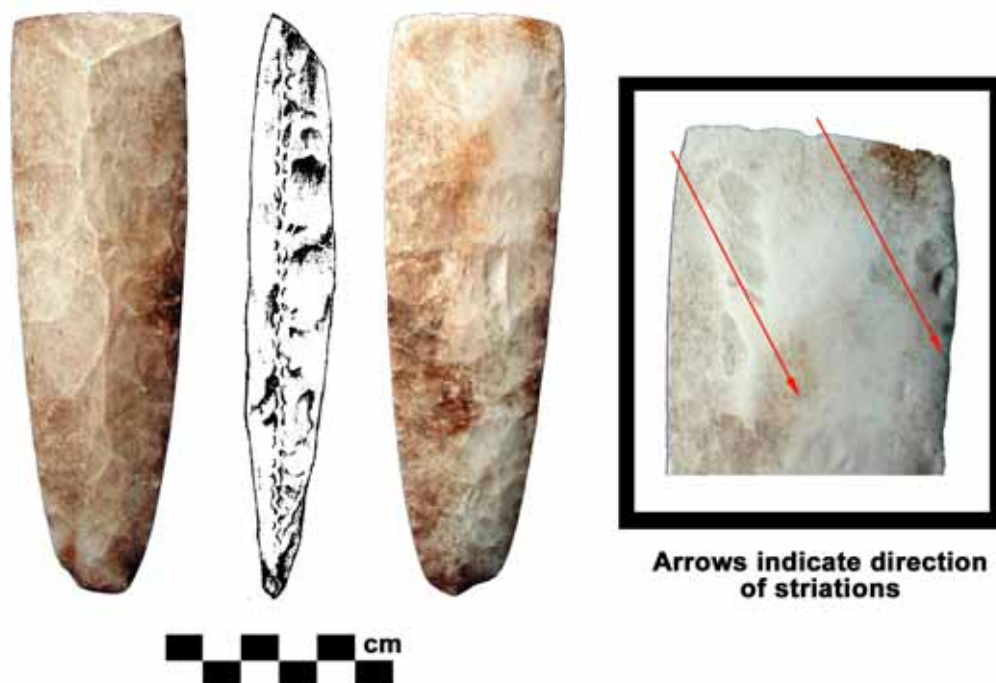


Figure 63: Ground-bit, plano-convex planer recovered in excavations at Blue Creek and Bedrock, Belize.

This tool form is rare in lowland lithic assemblages. A similar tool was reported by Andrews and Rovner (1975) from a cache at Muna in the northern lowlands. The authors simply refer to the tool as a chert adze. Three of these tools were recovered in excavations at Blue Creek. Only one was complete (Table 54). These date to the Late Preclassic and Late Classic periods. The example shown in Figure 63 above was surface collected from a disturbed cache at the site of Bedrock and is believed to be Late Preclassic to Early Classic in date.

The tool form is celtiform to sub-triangular in outline and plano-convex in cross-section. The form exhibits a dorsal ridge that terminals distally at the plane of the bit. This ridge does not appear to have been created as the result of the tool being crafted

from a macroblade core. Rather, it was intentionally created in production. The distal face of the tool form was created through a controlled bending fracture, and was subsequently finely ground. Soft hammer techniques were used in latter phases of production. The ventral face of the tool displays broad, flat flake removals, producing a relatively level surface. The ventral face, distal face, and lateral margins of the tool are each finely ground and polished. Faint traces of diffuse polish are also observable on the dorsal ridge.

Use wear analysis of the Bedrock cache specimen suggests that the tool was not used as an adze. Rather, diagonal striations observed on the ventral face on the distal quarter indicate that the tool was used in a fashion consistent with planing; it was pushed along the surface of another object rather than being used to strike at an object. In addition, the distal margin of these tools is honed to a sharp, even edge, and extraordinary polish is observed on either facet of the bit. Adzing could not have resulted in the wear pattern observed.

The diffuse polish noted on the dorsal ridge and the ground and heavily polished lateral margins each suggest that this tool was not hafted, but instead hand-held or possibly wrapped in a sheath while being used. Given this, the dorsal ridge was undoubtedly intended to add additional strength to the tool and avoid bending fractures resulting from the over application of force. The pattern of polish, direction and character of striations, and suggested motion of use each suggest that this tool form was used in association with a craft industry – possibly woodworking or masonry.

Table 54: Ground-bit, palno-convex planer descriptive statistics.

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	1	245	245	245.00	.
LENGTH	1	142	142	142.00	.
WIDTH	1	58	58	58.00	.
THICKNESS	1	29	29	29.00	.
EDGE_ANGLE	1	75	75	75.00	.

Chisel / Gouge



Figure 64: Chisel / gouge tool forms recovered in excavations at Blue Creek (left) and Bedrock, Belize.

Chisel forms have been modestly reported from sites in the central lowlands and the Belize Valley (Figure 64). They are generally referred to as chisels or gouges, though no systematic study of use wear has been completed for this form. A total of 13 tools were recovered in excavations at Blue Creek. Only one tool was complete (Table

55). The majority (n=8) were recovered in Late Classic period contexts, though the form was in use at Blue Creek as early as the Late Preclassic.

Chisel forms were constructed out of macroflakes (and possibly macroblades) using hard and soft hammer techniques. Raw materials used in their fabrication include chalcedony, chert-chalcedony blends, coarse chert, and quartzite. Steep lateral margins were produced through pressure flaking on most tools. The tool is narrow and sub-rectilinear with parallel sides in outline and biconvex in cross-section. The distal bit is made through a hard hammer strike to the ventral face of the tool, producing a concave facet. The bit and lateral marginal are then finely ground. Grinding of the lateral margins appears to be directed at blunting the facet, while grinding of the distal bit is directed at producing a sharp, even edge.

The proximal tip of the tool is often unfinished or, minimally, thickened. Cortex may be retained on the proximal tip. Macroscopic analysis of the proximal tip also shows that there is often evidence of battering and diffuse polish located there. The lateral margins are often highly polished, as is the distal quarter of the ventral face and the dorsal face of the distal bit. Lateral striations on the distal quarter of the ventral face emanating from the distal bit were also noted on several tools. This pattern of wear suggests that this tool type functioned as a chisel. The battering and polish observed on the proximal tip likely derive from the use of a hardwood hammer in the process of chiseling. The distal polish and striations are likely the result of use against a medium-soft to medium-hard contact material. This tool form was not likely hafted. Similar to the ground-bit planer form described above, chisel forms were likely hand-held in use, possibly wrapped in cloth or leather.

Table 55: Chisel form descriptive statistics (only includes complete form recovered at Blue Creek).

	N	Minimum	Maximum	Mean	Std. Deviation
WEIGHT	1	62	62	62.00	.
LENGTH	1	74	74	74.00	.
WIDTH	1	33	33	33.00	.
THICKNESS	1	23	23	23.00	.
EDGE_ANGLE	1	80	80	80.00	.

Hammerstone



Figure 65: Varieties of hammerstone recovered in excavations at Blue Creek, Belize.

Hammerstones have been reported throughout the Maya lowlands and are an essential element in the technology of stone tool production. They date to all time periods. While there are temporal differences in the relative use of hard hammer production techniques relative to soft hammer (Shafer 1985), the characteristics of hammerstones are not time sensitive. Hammerstones at Blue Creek occur in Middle Preclassic through late Classic period deposits (Figure 65).

A total of 78 hammerstones have been recovered in excavations at Blue Creek, Sotohob, and the lithic production platform at Bedrock (Table 56). Raw materials used to construct hammerstones include quartz, quartzite, dolomite, chalcedony, chert-

chalcedony blends, and chert of various qualities. The density of the raw material used may have been an important characteristic as it would have had some effect on the nature of flake removals during production.

Hammerstones within the Blue Creek collection most often exhibit circumferential crushing, though wear is occasionally focused at a single or limited number of points. One particularly prevalent pattern at Blue Creek is the reuse of distal celtiform biface fragments as hammerstones. The remnant edges on broken biface fragments would have provided a sharp contact point, creating more accurately directed flake removals during tool production and maintenance.

Table 56: Hammerstone descriptive statistics (includes primary and secondary forms).

	<i>N</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Mean</i>	<i>Std. Deviation</i>
WEIGHT	78	26	520	177.41	85.281
LENGTH	78	37	101	67.45	14.282
WIDTH	78	36	95	59.54	9.751
THICKNESS	78	16	67	35.90	9.671

Eccentric Forms

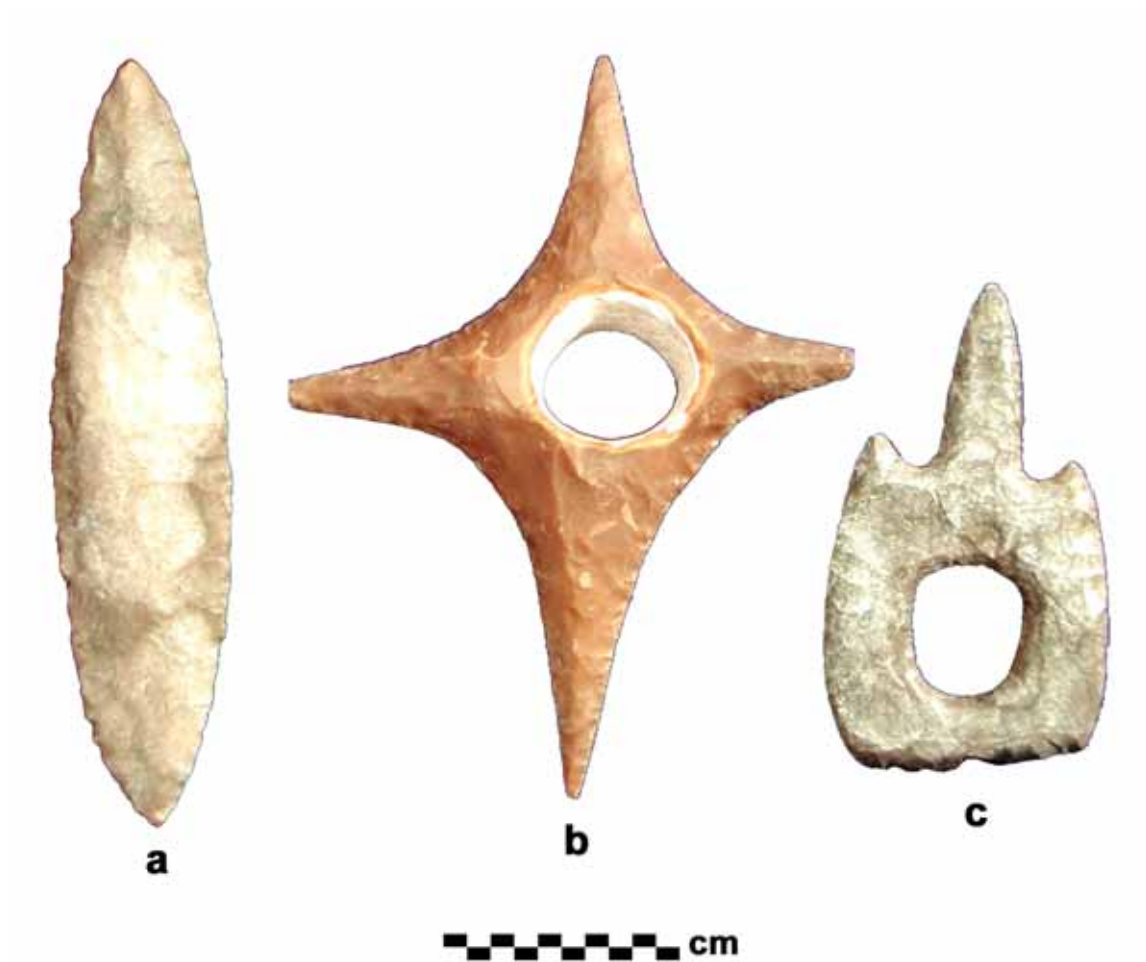


Figure 66: Eccentric cherts recovered in excavations at Blue Creek, Belize.

A Late Classic lithic cache containing 20 obsidian blades, 21 stemmed bifaces, one large laurel-leaf biface (Figure 66 a), and one tri-pronged eccentric (Figure 66 c) was located at Structure 37, an elite plazuela above the escarpment (Hanratty 2002). All non-obsidian stone tools in the cache were made from exotic FGB chert (see Chapter V

for raw material description). The large laurel-leaf biface measures 34.8cm in length, 8.2cm in width, and 2.3cm in thickness, weighing 694 grams. Pressure flaking is observable along the length of the artifact lateral margins, and there is no evidence of use modification. It is unlikely that this tool was intended for a utilitarian purpose. Although large laurel-leaf bifaces with similar attributes of manufacturing and of similar size are not very common, they have been recovered from cache or burial deposits at several lowland sites (Coe 1959; Gibson 1986; Ricketson and Ricketson 1937; Thompson and Shepard 1939; Thompson 1948; Willey et al. 1965; Willey 1972).

The tri-pronged eccentric is of extraordinary craftsmanship. The form measures 21cm in maximum length, 12.4cm in width, and 1.9cm in thickness, weighing 392 grams. The main body of the form is roughly square in outline with a perforated central area measuring 5.75cm x 3.5cm. Center perforations from eccentrics produced at the site of Colhá, Belize have been described as being formed through the advantageous selection of cobbles with natural carbonate inclusions (Eaton et al. 1994; Shafer 1991). There is no indication that a similar strategy was employed in manufacturing the tri-pronged form in the Blue Creek lithic cache. It is possible that the perforation was intentionally drilled or otherwise placed in the form during the early stages of manufacture, and enlarged through indirect percussion techniques and pressure flaking.

Three points extend from the upper lateral margin, with the central point being considerably longer and the outer points being of equal length. Each of the points is finely pressure flaked, though the main body of the form is not. No use modification is notable. Similar forms have been noted at other sites (Coe 1959; Ricketson and Ricketson 1937; Thompson and Shepard 1939). However, identical forms are rare in the lowlands. Several eccentrics recovered in excavations at the site of Piedras Negras appear to be variants of the form (Coe 1959, Figs.: 4a, h, l; 6n; 7a-l; 9v; 11a, d-i; 14e; 15p; 16d, k; 17l; 18b-e, m). Other examples, recovered at the site of Altar de Sacrificios are much closer in design and workmanship (Willey 1972, v.62[2], Figs. 144a, 147; 1972, v.64[1], Figs. 169; 170 bottom), and Thompson (1948, Fig. 23) recovered two tri-

pronged eccentrics of remarkably similar design in excavations at the site of El Baul, Guatemala.

A perforated, four-pointed cruciform eccentric was located at the base of the Structure 4 shaft cache (see Figure 21) that was filled with offerings of polychrome ceramics and jadeite artifacts (Guderjan 1998). The caches dates to the early sixth century. The eccentric measures 33.6cm in maximum length (vertical measure in Figure 66b), 24.6cm in maximum width (horizontal measure in Figure 66b), and 3.4cm in maximum thickness (measured at perforation), weighing 1800 grams. The center perforation measures 7.2cm across and was created by exploiting a natural carbonate vein running through the material. The raw material is unmistakably northern Belize honey brown chert, and this tool form was certainly crafted at the site of Colhá.

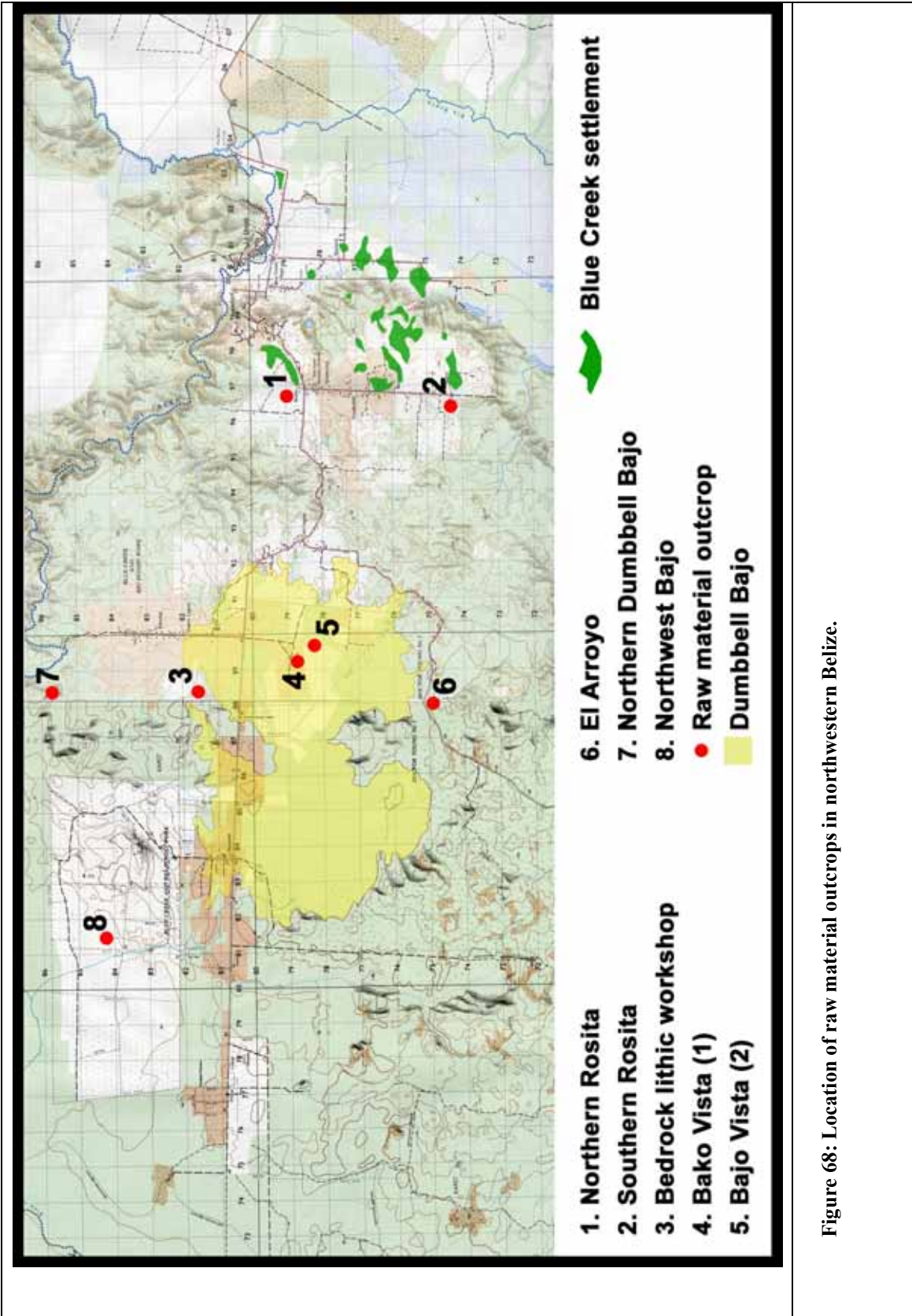


Figure 67: "Snowflake" eccentric forms recovered in excavations at Blue Creek, Belize.

The eccentric form that I have called a “snowflake eccentric” (for lack of more obvious or appropriate terminology) is a rather enigmatic form (Figure 67). I may have identified these artifacts as practice pieces were it not for similar artifacts being found in cache deposits along side more recognizably symbolic forms (Coe 1959, Figs. 5d, 15a; Willey 1972, p.206, Fig.189; Willey 1978, p.136, Fig.123). The snowflake forms found at Blue Creek look like little more than an artisan practicing notching techniques. They are crafted from flakes and circumferentially notched. These forms were not necessarily imported to Blue Creek in their final form, but may have been made from flakes removed from larger pieces during recycling or following breakage.

APPENDIX B

RAW MATERIAL DESCRIPTIONS



Lithic Resources from the Northern Rosita Outcrop



Figure 69: Raw materials collected from the northern Rosita outcrop.

Tabular cores of sedimentary quartzite and coarse grained chert are available in modest quantities in the small *bajo* near the Rosita precinct within the Blue Creek settlement zone (Figure 68). Nodules of silicified limestone are also available. Chalcedony and fine grained chert occur as lenses through coarser materials, but are not represented as homogenous cobbles. Quartzite is by far the most abundant resource available in the area.

Northern Rosita material was identified among the lithic artifact assemblage at Blue Creek based on color, grain size, mineral and fossil inclusions (Figure 69), and general lithologic properties. This material would have to have been thermally treated to offer real utility in stone tool manufacture. Regardless, the northern Rosita area in the most productive lithic raw material source in the Blue Creek settlement zone.

Lithic Resources from the Southern Rosita Outcrop



Figure 70: Raw materials collected from the southern Rosita outcrop.

The majority of raw materials collected from the southern Rosita outcrop were found in association with a dry arroyo (Figure 68). These consisted of coarse grained cherts, chalcedonies, chert-chalcedony blends, and silicified limestone (Figure 70). Most raw materials were in the form of modest to small sized cobbles. Chalcedonies were generally heavily occluded with cavities and crystalline pockets. Cherts were riddled with crystalline veins and fossil inclusions. Materials of any quality are scarce in this area.

Southern Rosita material was identified among the lithic artifact assemblage at Blue Creek based on color, grain size, mineral and fossil inclusions, and general lithologic properties. Most of the material within this zone would have had to have been thermally treated to offer real utility in stone tool manufacture. The small size of cobbles and general severity of inclusions would have significantly limited the utility of lithic resources in this area.

Resources from the Bedrock Lithic Workshop Outcrop



Figure 71: Raw materials recovered from the lithic workshop platform at Bedrock.

The lithic production platform within the Bedrock settlement zone is located on a ridge of elevated land reaching out into the northern extent of the Dumbbell Bajo (Figure 68). Lithic resources are prolific across this ridge, facilitating the intensive production observed at the workshop platform. The resource in greatest abundance is chalcedony, with chert-chalcedony blends, chert of various quality, and travertine also available (Figure 71). The vast majority of debitage at the production platform was chalcedony. This may reflect material preferences of the ancient artisans or simply reflect overall material availability.

Lithic resources on the ridge generally outcropped as large, tabular cobbles. Raw materials from this northern sector of the Dumbbell Bajo were identified among the lithic artifact assemblage at Blue Creek based on color, grain size, mineral and fossil inclusions, and general lithologic properties. The fossil inclusions found in Dumbbell Bajo materials are notably distinct from those observed among the resources available within the Blue Creek settlement zone.

Lithic Resources from the Dumbbell Bajo Deposit 1 Outcrop



Figure 72: Raw materials recovered from eastern Dumbbell Bajo (deposit 1) near the Bajo Vista settlement precinct.

Two highly productive raw material outcrops were discovered in the east-central area of the Dumbbell Bajo (Figure 68). The outcrops are in the form of elevated mounds that rise out of the surrounding flat landscape of the *bajo*. Each mound is composed of cherty gravels and tabular nodules of chalcedony. The chalcedony is of exceptionally high quality, and nodules are notable for their compositional homogeneity (Figure 72). Unequivocal evidence for intensive lithic production is observable at both deposits. In fact, over-exploitation may have resulted in the exhaustion of the resource at each of the nodes, but further archaeological testing will be needed to confirm this speculation. Much of the material at both resource nodes appears to have been thermally altered to varying degrees. However, as all materials were surface collected, heating may have been produced as the result of modern agricultural practices in the area.

The material at the first resource node (deposit 1) was identified among the lithic artifact assemblage at Blue Creek based on color, grain size, mineral and fossil inclusions, and general lithologic properties.

Lithic Resources from the Dumbbell Bajo Deposit 2 Outcrop



Figure 73: Raw materials recovered from eastern Dumbbell Bajo (deposit 2) near the Bajo Vista settlement precinct.

The raw material sample from the second outcrop in the east-central Dumbbell Bajo is composed of exceptionally high quality chalcedony and agate (Figure 73). This resource node exhibits some of the most prolific evidence for lithic production observable in and around the *bajo*. Raw materials outcrop as moderate sized tabular nodules.

The material at the second resource node was identified among the lithic artifact assemblage at Blue Creek based on color, grain size, mineral and fossil inclusions, and general lithologic properties. Materials from the second east-central *bajo* resource node were particularly identifiable due to the unique banding observed on many of the pieces.

Lithic Resources from the El Arroyo (PFB) Outcrop



Figure 74: Raw materials covered from El Arroyo (PFB).

The raw material sample from El Arroyo, in the Programme for Belize project area (PFB) is composed of exceptionally high quality chalcodony (Figure 74). The homogeneity of material within any one cobble is particularly exceptional, and evidence for lithic production is observable at this site. Raw materials outcrop as moderate sized tabular nodules. Lithic resources may have been heat treated prior to or during production based on observed material vitrification. However, as all materials were surface collected, thermal alteration may have been post-depositional.

El Arroyo material was identified among the lithic artifact assemblage at Blue Creek based on color, grain size, mineral and fossil inclusions, and general lithologic properties. A substantial portion of the tool forms in the Blue Creek lithic assemblage (23.4%) were crafted from raw materials associated with Dumbbell Bajo outcrops (including El Arroyo, Bajo Vista, and Bedrock).

Lithic Resources from an Outcrop North of the Dumbbell Bajo



Figure 75: Raw materials recovered from north of the Dumbbell Bajo.

Raw materials recovered from an area of ancient Maya settlement north of the Dumbbell Bajo can be largely characterized as chalcedony, coarse grained cherts and chert-chalcedony blends (Figure 75). Chalcedony seems quite rare in this area, and was only represented by two preforms. It is possible that the preforms were obtained from one of the workshops on the periphery of the Dumbbell Bajo. Chert-chalcedony blends were the most common raw material type observed. These were typically identified as moderate to small sized tabular nodules. No production debris was found in this area, but several preforms were discovered.

Raw materials emanating from outcrops north of the Dumbbell Bajo were identified among the lithic artifact assemblage at Blue Creek based on color, grain size, mineral and fossil inclusions, and general lithologic properties. Most of the material

within this zone is likely to have been thermally treated for stone tool manufacture. The small size of cobbles and general severity of inclusions would have significantly limited the utility of lithic resources in this area. Very few tools in the Blue Creek lithic assemblage were identified as having come from this resource node.

Lithic Resources from an Outcrop Northwest of the Dumbbell Bajo



Figure 76: Raw materials recovered from northwest of Dumbbell Bajo.

Raw materials recovered from a gravel quarry northwest of the Dumbbell Bajo can be primarily characterized as coarse grained cherts and quartzites. Unique banding patterns and mineral inclusions assisted in identifying materials from this resource node among the tool assemblage from Blue Creek (Figure 76). Raw materials outcrop at this resource node mainly in the form of large cobbles and boulders.

Lithic materials from the quarry have low utility in tool manufacture owing to highly inconsistent properties within nodules. The resource node is a modern quarry, and no evidence for lithic production by the ancient Maya of the area was encountered. Very few artifacts in the Blue Creek lithic assemblage derive from this resource zone.

Lithic Resources from Colhá, Belize



Figure 77: Raw material sample from Colha in the northern Belize chert-bearing zone.

Cherts from the northern Belize chert-bearing zone (NBCZ) have been studied extensively (Cackler et al. 1999; Hester and Shafer 1984; Tobey 1985; Tobey et al. 1994). Cherts in this zone outcrop as nodules of varying size and their material properties are remarkably homogenous throughout the zone (Figure 77). Chemical characterization studies using instrumental neutron activation analysis (INAA) have shown that NBCZ cherts are identifiable from lithic raw materials occurring outside the zone, but individual outcrops are often unidentifiable within the zone.

NBCZ cherts vary in quality from moderately coarse to exceptionally fine grained. Some varieties exhibit a distinct banding of pattern, and several varieties include microfossil spiculae. The fine grained honey-brown chert is among the finest in the lowlands. Coarser grey varieties exist, but they are very dense and able to be easily flaked into tool forms. NBCZ cherts do not appear to have been heat treated as a stage in their manufacture. In fact, these cherts tend to fracture and become unusable when heated. NBCZ cherts are highly identifiable based on their visual properties. They constitute a substantial portion of the Blue Creek lithic assemblage.

VITA

Jason Wallace Barrett was born on April 25, 1970 in Providence, Rhode Island. He attended public school in Glocester, Rhode Island from 1975 until 1988 when he graduated from Ponagansett High School. He enrolled in Rhode Island College in the fall of 1989, and graduated in 1994 with a B.A. in anthropology, with a specialization in public archaeology. From the fall of 1993 through the summer of 1995, Jason worked at the Public Archaeology Laboratory, Inc. in Pawtucket, Rhode Island. While there he participated in all phases of historic and prehistoric site investigation within the states of Rhode Island, Connecticut, Massachusetts, and New Hampshire. In the fall of 1995, Jason entered the graduate program in anthropology at Texas A&M University, receiving his M.A. in December 1999. In January 2000, Jason entered the Ph.D. program in Anthropology at Texas A&M University, receiving his Ph.D. in December 2004.

Jason assisted in survey and reconnaissance at Hacienda Tabi, Yucatan, Mexico during the summers of 1996 and 1999, and served as excavation supervisor for the Belize Postclassic Project at the site of Caye Coco, Belize during the summer of 1998 and 1999. In the summer of 2000, Jason began the field research for his dissertation at Blue Creek, Belize. He studied lithics and supervised excavations at Blue Creek from the summer of 2000 through the summer of 2003. In the summer of 2004, Jason participated in archaeological research on American Samoa.

His archaeological experience includes site survey, excavation, artifact conservation, and on-site training of field school participants. His specialties include the analysis of stone tools and lithic production debris, conservation of metallic artifacts from underwater archaeological sites, and the application of computer graphics in archaeology. Jason can be reached through the Department of Anthropology, Texas A&M University, College Station.